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# THE FIELD AND FUTURE OF THE LOW-PRESSURE STEAM TURBINE.

*By Ira N. Hollis.*

## II. A SURVEY OF HISTORY, AND EXAMPLES OF INSTALLATIONS.

In a preceding paper, published last month, Professor Hollis discussed the fundamental theory and the fields of usefulness of the low-pressure turbine. The section here presented covers the historic development and applications to stationary service in America. A concluding installment, which will appear in the July issue of the Magazine, will deal with marine installations of this type in the light of the latest experience.—THE EDITORS.

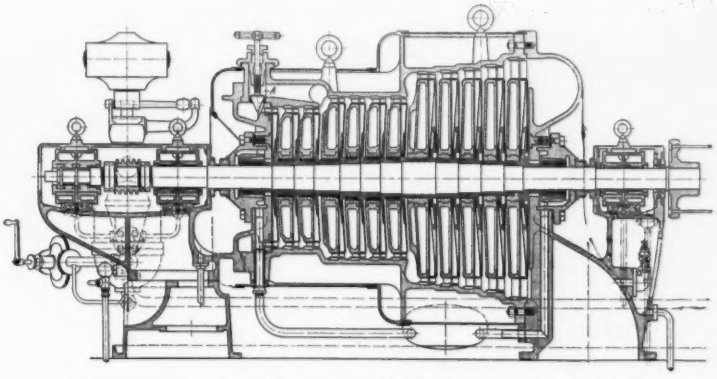
THE history of the low-pressure turbine is a brief one. A patent was taken out in 1894 for the combination of the Parsons' turbine and the reciprocating engine, with the object, as stated by Mr. Parsons, of "increasing the power obtainable by the expansion of steam beyond the limits possible with the reciprocating engine." The earliest example of a low-pressure turbine taking exhaust steam was in the torpedo boat Turbinia, but the exhaust came from a high-pressure turbine and not from a steam engine. The initial exhaust pressure was 9 pounds absolute. The actual combination of a reciprocating engine and a steam turbine was not put to a practical test until 1902, when two inventors tried it on radically different lines. Mr. Parsons installed it in the destroyer Velox, where the reciprocating engines were fitted to the same shafts as the low-pressure turbines for driving the centre screws. The wing screws were coupled to high-pressure turbines. For cruising speed, the steam passed successively through the reciprocating engine, the high-pressure turbine, and the low-pressure turbine; and the economic results were good. For high speed, the reciprocating engines were uncoupled, and the steam passed from the boiler direct to the

RATEAU EXHAUST-STEAM TURBINE AT THE WISCONSIN STEEL COMPANY'S MILL, SOUTH CHICAGO.

700-kilowatts capacity, direct connected to direct-current dynamos. Western Electric Co.

high- and low-pressure turbines successively. While Mr. Parsons seems to have thought of all possible applications of the turbine, Professor Rateau made the first commercial use of the combination for stationary purposes, at the Bruay mine in 1902. He has given an excellent description of his system in the *Revue de Mécanique* for October, 1907, and a very good idea of his claims may be found in the article published by THE ENGINEERING MAGAZINE in 1907. An interesting example of its application to mill work in the United States is found at the Wisconsin Steel Company's mill at South Chicago. The primary engine is of the double-cylinder type, 42 inches by 60 inches, operating the rolls for 19 steel ingots an hour. There is frequent stopping and reversing, and the engine is practically idle 20 per cent of the time. The intermittent exhaust, which was formerly turned into the atmosphere, passes now into a heat-storage tank, or regenerator, from which it emerges in a continuous flow of steam at atmospheric pressure. The turbine driven by this steam is connected to two direct-current units of 250 kilowatts each. A full description of this plant was given in a paper by Mr. H. H. Wait, at the December, 1907, meeting of the American Institute of Electrical Engineers, to which readers of THE ENGINEERING MAGAZINE are referred for details. The great economic gain is self-evident. The Rateau system for mills and mines has made great strides in France

and England, and its successful development in the United States under the Western Electric Company is only a question of time.

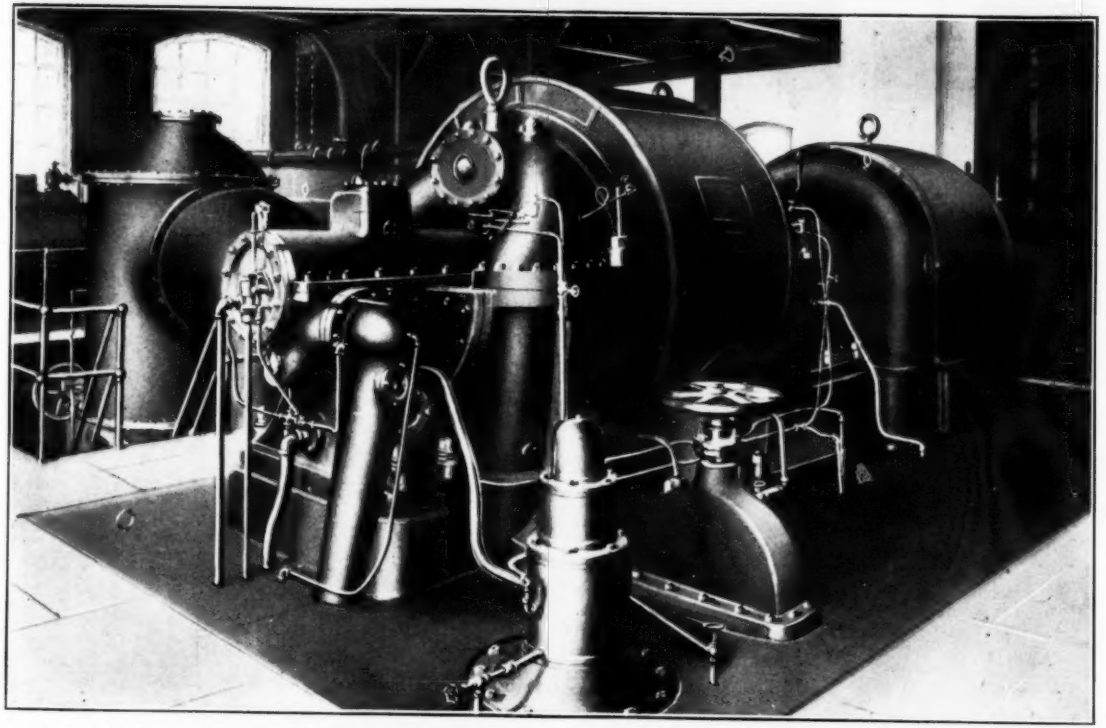


LONGITUDINAL SECTION OF RATEAU LOW-PRESSURE STEAM TURBINE.
Western Electric Co.

The first paper on the low-pressure turbine of the Curtis type was read before the International Electric Congress at St. Louis, in 1904, by Mr. W. L. R. Emmet, whose work in connection with the combination of reciprocating engines and turbines has been of the highest importance in demonstrating that the economic operation of all existing steam engines, even of the condensing type, may be improved. A further impetus to the adoption of the low-pressure turbine as a practical method of saving coal in old steam-engine plants, has been given by Mr. H. G. Stott, chief engineer of the Interborough Rapid Transit Company, of New York, who accepted it for one of the large units at the 59th Street station.

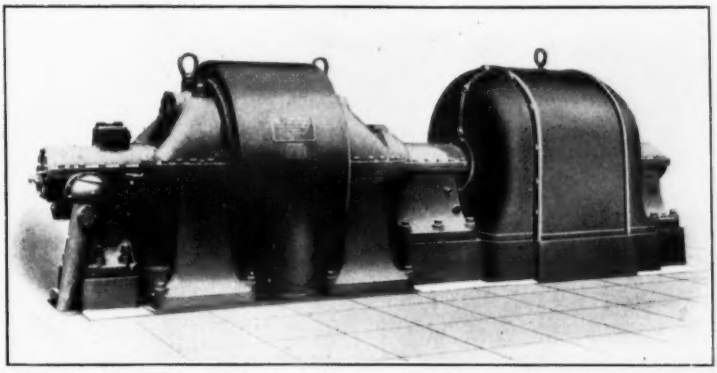
The low-pressure turbine of the Parsons type, as built in the United States by the Westinghouse Machine Company, has proven very satisfactory. It should be more advanced in design than the Curtis type, to be mentioned later, because it has long been used with high-pressure turbines for marine purposes. Many such machines have been operated successfully for years. A good example of the Westinghouse-Parsons turbine in connection with a reciprocating engine is here taken from an article by Mr. J. R. Bibbins read before the Canadian Society of Civil Engineers last November.

It is found in the plant of the United States Coal and Coke Company, at Gary, W. Va. It operates the mining property, serving hoists, pumps, blowers, lights, etc. The plant contains two 24 and 44 by 42 Corliss engines, 750 kilowatts, one 1000-kilowatt complete-expansion steam turbine, and a 1000-kilowatt low-pressure steam turbine, both of the Parsons type. These turbines are served by three cooling-tower units, fan-driven,



WESTINGHOUSE DOUBLE-FLOW LOW-PRESSURE STEAM TURBINE, 1,000-KILOWATTS CAPACITY, IN PLANT OF U. S. COAL & COKE CO., GARY, W. VA.

The Westinghouse Machine Co., Pittsburg.

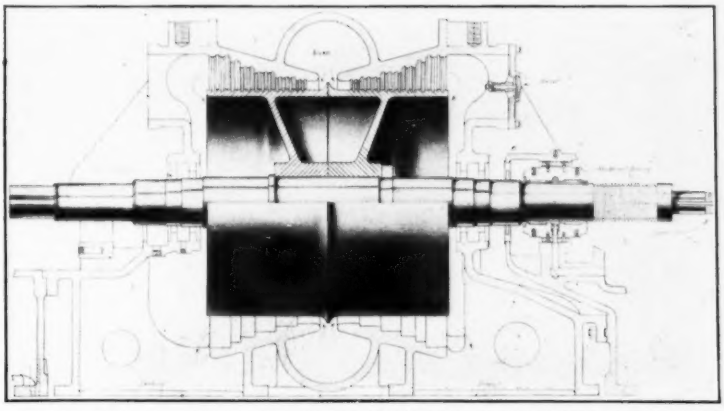


WESTINGHOUSE-PARSONS LOW-PRESSURE DOUBLE-FLOW TURBO-GENERATOR UNIT, WITHOUT GOVERNOR.

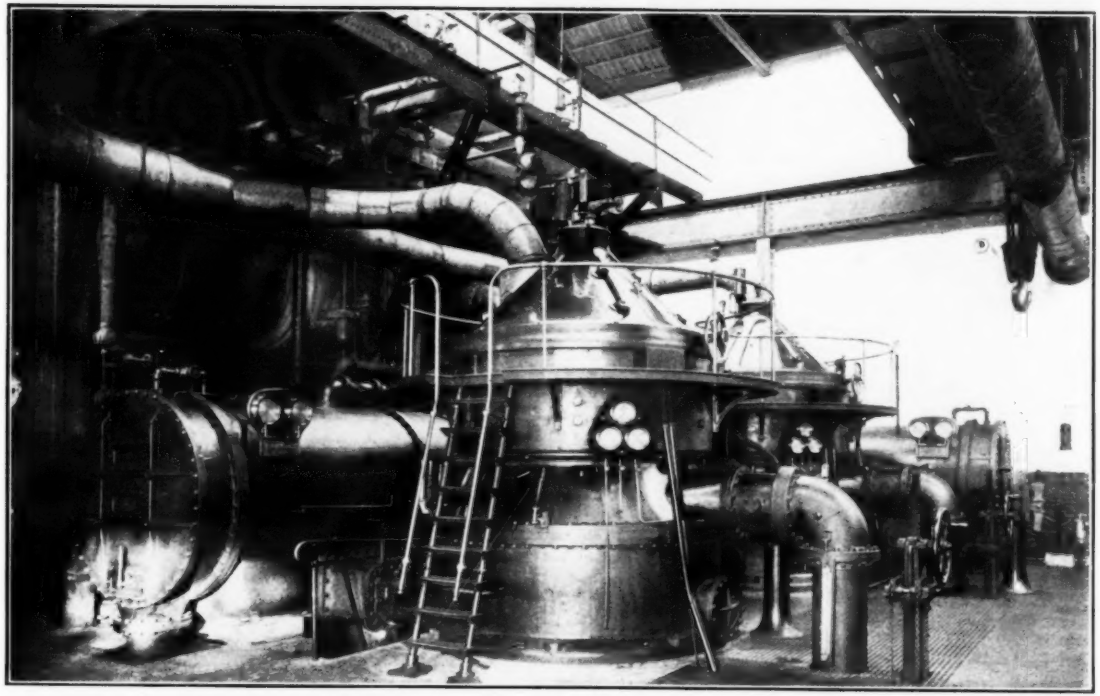
each 24 feet in diameter and 25 feet high. The following figures roughly indicate the normal operation of the generating units from readings taken October 7, 1908:

| | | |
|---|---|---|
| Output of two Corliss engines | 1400 | kilowatts |
| Output of low-pressure turbine | 1200 | kilowatts |
| Steam pressure (gauge) | 150 | pounds |
| Vacuum low-pressure turbine (rfd. to 30 in.) | 25.8 | inches |
| Temperature of injection | 88 | degrees |
| Temperature of air | 85 | degrees |
| Cooling in tower | 31 | degrees |

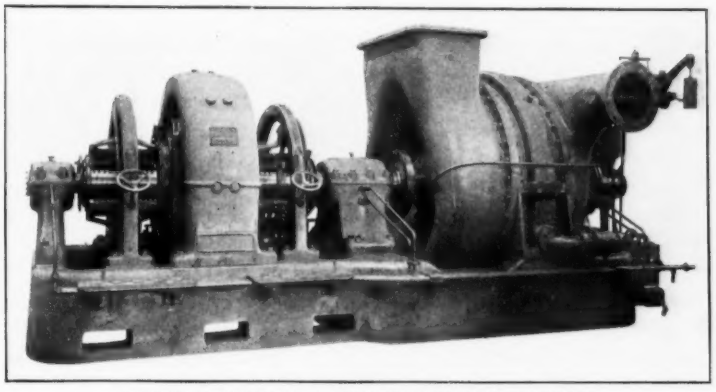
Thus the low-pressure turbine carried nearly half the total load on less than 26-inches vacuum, and would have carried more than 1500 kilowatts on 28-inches vacuum, with better condensing conditions, giving a probable water rate for the engine-turbine plant of approximately 18.5 pounds per kilowatt-hour.



LONGITUDINAL SECTION OF WESTINGHOUSE-PARSONS LOW-PRESSURE DOUBLE-FLOW STEAM TURBINE.



CURTIS LOW-PRESSURE STEAM TURBINE, 800-KILOWATTS CAPACITY, VERTICAL TYPE.
The General Electric Co., Schenectady, N. Y.

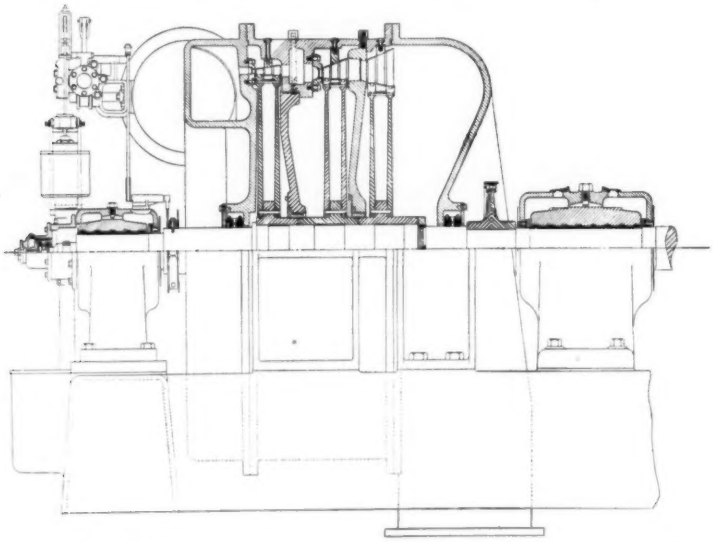


CURTIS HORIZONTAL LOW-PRESSURE STEAM TURBINE.
500 kilowatts, connected to 4-pole generator, 1500 r.p.m. General Electric Co.

The first low-pressure turbine of the Curtis type was put into a power station of the Philadelphia Rapid Transit Company, in 1905. This station is located at Thirteenth and Mt. Vernon Streets, where a good supply of condensation water is not available. The original plant consisted, therefore, entirely of non-condensing engines, delivering about 5,500 kilowatts to the switchboard. One low-pressure turbine and generator was installed in January 1905, and one year later a second unit was added, so that there are now two 800-kilowatt direct-current machines, taking steam from an open exhaust pipe in which the supply is always in excess of the turbine demand. A cooling tower was needed and this, with an Alberger condenser having 8,000 square feet, gives an average vacuum of 28 inches. The design of the turbine is comparatively simple, as it has four discs, with a single row of buckets on each. The generator is a direct-current machine making 1,200 revolutions per minute, and there is no governor. The two dry air pumps, two discharge pumps, and one step-bearing pump are driven direct by steam cylinders, while the other auxiliaries are motor driven. The guarantee, with 15 pounds absolute at the turbine and 1 pound back pressure, was 36 pounds per kilowatt-hour for the turbine alone. Some idea of the gain in economy may be obtained by the following record for the year preceding the installation of the turbines, and the year succeeding.

| | 1904 | 1906 |
|---|---|---|
| Average kilowatt hours per month..... | 2,475,000 | 2,957,500 |
| Average cost per kilowatt hour..... | 7.30 mills | 6.03 mills |
| Average weight of coal per kilowatt hour.... | 4.60 pounds | 4.08 pounds |
| Average cost of coal per kilowatt hour..... | 5.15 mills | 4.50 mills |

During the year 1906, the turbine carried only 16.8 per cent of the load, and, notwithstanding this small contribution, the saving in coal amounted to 11.3 per cent. Taking the cost at three dollars per ton, the saving for the year 1906 would have been about $28,000. The actual saving probably exceeded that, on account of a change in the price of coal. The improvement might have been carried still farther by recovering energy from all of the exhaust steam. As it was, the greater part of it passed through the escape pipe directly into the atmosphere, rather than through the turbines. The reason for the great gain in this case is self-evident, and there can be no valid argument against the turbine for such service. But it would have been equally possible to put in cooling towers and condensers for the steam engines, and thus to get back a large part of the energy passing away in the exhaust steam. Part of the gain is therefore chargeable to condensation, and the real merit of the case lies in the fact that the turbine makes a better use of the vacuum than a steam engine.



ASSEMBLY OF 1,000-KILOWATT LOW-PRESSURE CURTIS STEAM TURBINE, HORIZONTAL TYPE.

A number of these combinations have been made for non-condensing plants by the General Electric Company, and the saving of coal has justified them in every instance. But by far the most interesting is one in process of construction for the Interborough Rapid

Transit Company of New York. The turbine is to take steam from a 5,000-kilowatt unit installed when the station was first built. It will afford a real test of the combination of a steam engine and a steam turbine operating together as a unit on a large scale. Furthermore, it will establish for the first time, definitely and practically, the possibility of gain in economy and power when a steam engine with a condensing plant of its own is turned into a non-condensing engine with a low-pressure turbine in sequence. The turbine was ordered by the Interborough Rapid Transit Company for one of the units at the 59th Street station, after a thorough investigation of the subject by Mr. H. G. Stott. This began with a determination of the water rate of the existing engine through a wide range of load, by actual measurements at certain loads. The steam consumption of the engine when operating condensing as determined by test, was 17½ pounds per kilowatt hour, at 4,000 kilowatts, which was the most economical load. With loads actually carried, the average water rate is not better than 18½ to 19 pounds per kilowatt hour. Tests were also made to determine the quality of the steam exhausted from the engine at various loads, and corrections for moisture thus served to give all the necessary data for estimating the results expected from the combination unit.

The steam-engine unit consists of two compound Corliss engines connected to a common shaft upon which is mounted the revolving field of a 5,000-kilowatt electric generator. The high-pressure cylinders are horizontal, and the low-pressure cylinders vertical, of diameters 42 inches and 86 inches, with a piston stroke of 60 inches. The steam is supplied to the engine substantially dry, at a pressure of 186 pounds, and the speed is 75 revolutions per minute.

The turbine will take its steam from the two low-pressure cylinders, at atmospheric pressure, or thereabouts, and will be of 5,000 kilowatts normal rating. It will be of the vertical type, with a base condenser containing about 20,000 square feet of surface in 1-inch tubes. A vacuum of 28½ inches should easily be maintained, and the steam consumption of the turbine at its rated load should not exceed 29 pounds per kilowatt. The turbine will have three revolving discs, with two rows of blades on each. The total periphery of the three wheels will be open to the flow of steam, but the first stage will be provided with hand valves for changing the number of admission nozzles, thus putting it within the power of the engineer to fix the initial pressure at any desired amount, as the load changes. The generator will be of the induction type and will deliver current to the same cables as the engine-driven generator, without intervening

switching apparatus. The combination will therefore become, as regards output, a single unit, and no governor will be required on the turbine except the usual emergency stop.

The reciprocating engine is capable of developing, when operating non-condensing, about 7,500 kilowatts. The boilers fairly assignable to this unit should supply about 170,000 pounds of steam per hour. This should give very close to 7,300 kilowatts in the engine and 5,300 kilowatts in the turbine, or 12,600 kilowatts in all. The combined water rate will therefore probably be as low as 13.5 pounds per kilowatt-hour. If sufficient engines were run condensing to supply this power, at a water rate of 19 pounds, the steam consumed would be 239,400 pounds per hour; so that the saving effected by the turbine will be 69,400 pounds of steam per hour. The unit will naturally be run continuously, and under such circumstances the saving should be 1,660,000 pounds of steam per day of 24 hours. This should amount to something over $100,000 per year, at the prevailing cost of coal in New York; and the Interborough Company should thus be able to pay for the installation of the turbine in less than two years. A small amount of calculation will show that the above figures allow considerable latitude for stoppage of the unit. The cost of the new installation is less than $30. per kilowatt, and the actual gain is summed up by the General Electric Company as follows:

An increase of 63 per cent in the peak capacity (based upon 7,700 kilowatts for the maximum load of the engine when running non-condensing).

An improvement in fuel economy of about 29 per cent (based on the figures given above for steam expended per hour).

A water rate of 13.5 pounds per kilowatt-hour.

An annual saving of 38,000 tons of coal, as compared with the amount hitherto necessary for the generation of 12,600 kilowatts continuously.

All these claims seem entirely reasonable, and the new unit ought to come within reach of them. The following brief summary of the turbine data is supplied by the General Electric Company:

| | |
|---|---|
| Steam pressure (absolute) at the turbine | 15 to 16 pounds |
| Vacuum | 28½ inches |
| Speed | 750 R. P. M. |
| Frequency | 25 cycles |
| Voltage | 11,000 volts |
| Maximum capacity | 5700 kilowatts |
| Total weight | 577,000 pounds |
| Total weight of revolving parts | 110,000 pounds |
| Diameter of base | 15 feet |
| Height over all | 27 feet |

A careful study of the engines of the Cambridge Electric Light Company, after tests under various conditions, indicates for a small

engine a gain similar to that expected by the Interborough Company. The feed-water rate for a 500-kilowatt compound engine run condensing, built by McIntosh & Seymour, is 22.26 pounds per kilowatt-hour, including all auxiliaries; and this can be cut down to 16.77 pounds, a saving of 5.49 pounds per kilowatt-hour. As the unit, steam engine and turbine, could be run at 1,000 kilowatts for about fifteen hours a day, the saving would be 82,350 pounds of steam; and the total saving for one year, excluding Sundays, would exceed $6,000.

The operation of the combined steam engine and turbine in existing plants has proven satisfactory in practice, and the calculations of economic performance have been borne out, yet no power plant has been designed primarily with the combination in mind, except for marine purposes. One example of this is reported in the successful trial of the Otaki, built for the New Zealand Shipping Country. She is a sister ship of the Orari, which has only reciprocating engines. Both have precisely the same boiler installation. Under the same conditions, the Otaki made 15.09 knots as against 14.6 for the Orari. An estimate of the steam consumed for all purposes, based on a comparison with the Orari, gave the surprisingly low result of 12.3 pounds per horse-power hour. While this cannot be accepted as final, comparisons between two sister ships being often misleading, the Otaki is probably a very economical ship.

The auxiliaries, including pumps and condensers, required for a high vacuum with the low-pressure turbine do not differ in any respect from those used with the all-turbine station. They are therefore too well understood to need explanation in a short paper. The one important difference in the two types of machinery relates to oil and water separation before the steam enters the turbine. The former can be drained off by some kind of a separator, and the latter should be evaporated rather than separated, if it can be accomplished with waste heat. There is nothing gained by using live steam in the coils of a receiver to dry the exhaust from the cylinder, because there is no initial condensation to fear.

The governing of the low-pressure turbine has given no trouble where the current has been turned into the same bus bar, whether the turbine has taken only part of the exhaust or all of it. Where the turbine delivers the current to a different system from the engine, a governor is just as much a part of the machine as in a turbine acting alone. In all cases, an emergency stop is necessary.

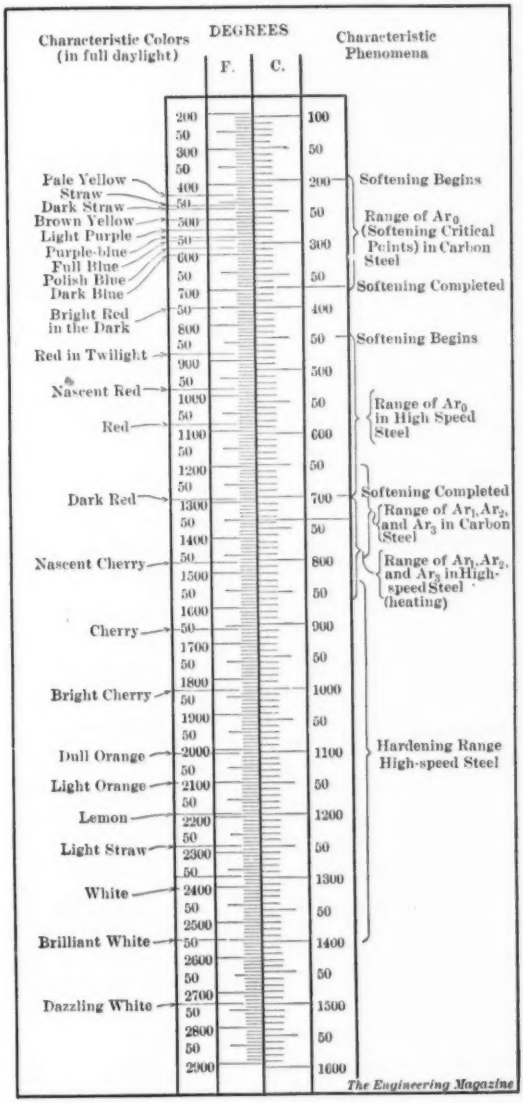
# TEMPERATURE DETERMINATION AND CONTROL FOR HIGH-SPEED STEEL TREATMENT.

*By O. M. Becker.*

In a series of two articles, of which this is the first, Mr. Becker reviews the methods and instruments in practical use for measuring and recording temperatures in industrial processes, especially in connection with the heat treatment of steel. In the following pages he emphasizes the importance of accurate temperature determination and duplication in the manufacture of high-speed steel tools, and discusses the principles and uses of pyrometric devices designed for direct exposure to the heat to be gauged. The concluding section, to follow next month, will deal with pyrometers of the optical and radiation types, the choice and installation of temperature measuring devices, and the importance of recording apparatus in connection with their use.—THE EDITORS.

GUESSWORK is not consistent with modern industrial methods. Guessing and rough approximation are uncertain, and therefore wasteful. It has of course always been true, but only in recent years has it come to be well understood, that the physical and chemical changes involved in so many productive industries take place under definite and constant conditions. Variation in conditions, whether it be in burning coal under a boiler, conducting an electric current, heating a baking kiln, treating a tool, or what not, involves variation in the nature or efficiency of the product; and in consequence also it involves waste. The conditions of maximum effect once definitely determined, it is of the first importance in nearly all industrial operations that they be reduplicated, within the established limits, with certainty and economy. The manufacture of high-speed steel tools forms no exception; on the contrary, the accurate gauging and reduplication of temperatures, especially high temperatures, is an absolute essential to anything approaching the maximum efficiency in tools.

Formerly a prime qualification of a successful toolsmith was the possession of a well-trained eye, the ability to discriminate sharply the colors through the wide range seen in the heating of a piece of steel—this that he might gauge with more or less accuracy the heat to be applied to the tools of various steels and for different uses when hardening or tempering. Not that the color scale had for him (usually, at any rate) any definite relation to specific temperatures; but rather because it was known to be more or less definitely related to the hardness and lasting quality of steel tools, the




HEATING PHENOMENA, FAHRENHEIT AND CENTIGRADE SCALES.

The cooling critical points ($Ac_1$, $Ac_2$, $Ac_3$), are from 25 to 75 degrees below the softening critical points $Ar_1$, $Ar_2$, $Ar_3$.

relation depending a good deal upon the particular steel used, and perhaps also upon other conditions. No matter how skilful a toolsmith might be, however, his tools, carefully made as nearly uniform as might be, still turned out varying more or less in quality. As we now know, this of course is just what might be expected under the circumstances. Until lately nothing was known of the critical or recalescence and decalescence points in steel, the precise location of which in the temperature scale must be known before the proper heat for any particular steel can be determined. Even if they had been known, their precise location by reference to the colors as perceived in a piece of

COMPARATIVE TABLE OF THREE WELL-KNOWN COLOR SCALES.

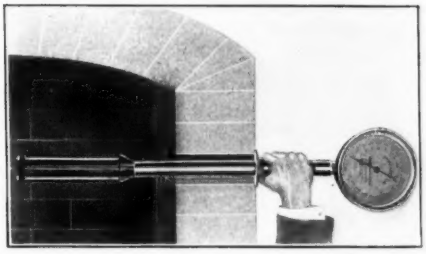
| | Cent. | Fahr. |
|---|---|---|
| **POUILLET.*** | | |
| Lowest red | 525 | 977 |
| Dark red | 700 | 1292 |
| Lowest cherry | 800 | 1472 |
| Cherry | 900 | 1652 |
| Bright cherry | 1000 | 1832 |
| Dark orange | 1100 | 2012 |
| Bright orange | 1200 | 2192 |
| White | 1300 | 2372 |
| Bright white† | 1400 | 2552 |
| Dazzling white | 1500 to 1600 | 2732 to 2912 |
| **TAYLOR & WHITE.** | | |
| Low, dark, or blood red | 566 | 1050 |
| Dark cherry | 635 | 1175 |
| Cherry, full red | 746 | 1375 |
| Light red | 843 | 1550 |
| Orange | 899 | 1650 |
| Light orange | 941 | 1725 |
| Yellow | 996 | 1825 |
| Light yellow | 1079 | 1975 |
| White | 1205 | 2200 |
| **HOWE.** | | |
| Lowest red visible in dark | 470 | 878 |
| Lowest red visible in light | 475 | 887 |
| Dull red | 550 to 625 | 1022 to 1157 |
| Full cherry | 700 | 1292 |
| Light red | 850 | 1562 |
| Full yellow | 950 to 1000 | 1742 to 1832 |
| Light yellow | 1050 | 1922 |
| White | 1150 | 2108 |

steel by the unaided eye would have been practically impossible. This is due not only to the difficulty of discriminating between the colors of a radiant body when those colors do not vary greatly, but even more to the personal equation of the observer and the variation in the conditions under which the observations are made.

Not only do persons differ as to just what is, say bright red or light yellow, or any other color for the matter of that; but in the same person the judgment will vary with his freedom from fatigue, his physical condition, and even his moods. Furthermore, the light in which colors are seen modifies them to a considerable extent, so that seen in one part of a shop a piece of steel of a given tempera-

* Pouillet over seventy-five years ago devised his color scale, which even to this day is quoted as authoritative, though his instruments for gauging temperatures were by no means comparable with those in use today and his results, or his nomenclature at any rate, are not very well in accord with more recent scales, as may be seen in the table above.

† It is impossible, in tool-making practice, to discriminate with any accuracy the hues generally called white.

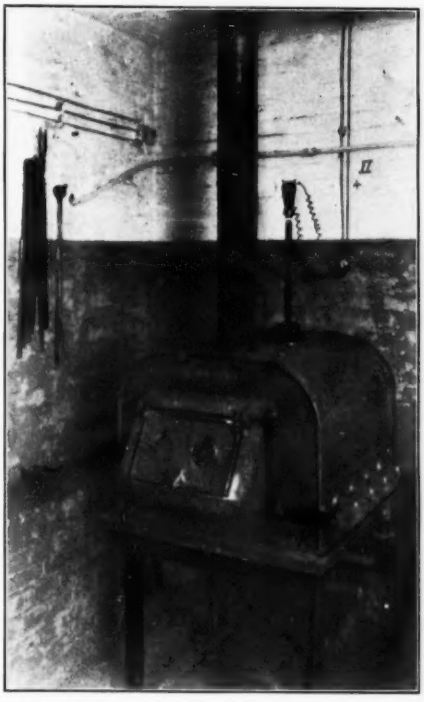


BROWN PLATINUM PYROMETER FOR INTERMITTENT SERVICE.

Edward Brown & Son, Phila.

ture might appear to have one color, while in another part of the same shop it might appear several shades different. Even in the same spot in a shop the light is bound to vary a good deal according to the cleanness of the window and the condition of the weather outside. Of course when artificial light is necessarily used part of the time, the difficulty is still further increased. The difficulties arising from the personal equation, even in the case of skilled observers, are well seen in the comparison of three well-known color scales, shown on the opposite page.

Very evidently dependence upon the eye for the determination of temperatures and their accurate reproduction leads to very uncertain, and in the case of high-speed steels rather unsatisfactory, results. It is quite as evident that in the treatment of a commercial product as expensive as a complicated tool, particularly when made of a material like high-speed steel, which requires for maximum effects even more care than the cheaper carbon-steel



LE CHATELIER FIRE END INSERTED IN OVEN FURNACE.

The indicator is connected to the lead wires at any convenient distance. Chas. Engelhard, N. Y.

TABLE SHOWING THE VARIOUS CLASSES OF PYROMETRIC APPARATUS WITH THE RANGE OF REPRESENTATIVE TYPES.

| Class. | Principle Involved. | Types. | Range. Centigrade. | Range. Fahrenheit. |
|---|---|---|---|---|
| Expansion. | Variation in volume of a substance by change of temperature. | Gas | 0—1000 | 32—1850 |
| | | Mercurial | − 40— 550 | − 39—1025 |
| | | Spirit | −210— 25 | −350— 75 |
| | | Pneumatic—gas | low— 980 | low—1800 |
| | | Metal rod, etc. | low— 485 | low— 900 |
| | | Porcelain (contraction) | low—1800 | low—3250 |
| | | Water current | 0—1600 | 32—2900 |
| | | Brown platinum | 0—1600 | 32—2900 |
| Pneumatic. | Flow of gases through small apertures. | Uehling | low—1650 | low—3000 |
| Calorimetric. | Relation of specific heat to quantity absorbed. | Siemens water pyrometer | low—1480 | low—2700 |
| Fusion or "Sentinel." | Unequal fusibility of various metallic or earthy cones. | Seger temperature cones, etc. | 0—2000 | 32—3600 |
| Thermo-electric. | Current developed when one junction of a thermo-couple is at a temperature differing from that of the other. | Le Chatelier, Hoskins, Bristol, Price, etc. | −180—1650 | −380—3000 |
| Resistance. | Variation in electrical conductivity under changes of temperature. | Le Chatelier | Lowest attainable—1200 | Lowest attainable—2200 |
| Radiation. | Measurement of heat radiated. | Féry | 900—1600* | 1650—2900* |
| | | Bolometer | † | † |
| Optical. | Variation in luminosity or wave length. | Morse—superposition of incandescent filament | 600—2000* | 1100—3600* |
| | | Le Chatelier mirror, Féry absorption, and Wanner—all photometric comparison | 500—2000*<br>900—1800* | 925—3600*<br>1650—3250* |
| | | Mesure & Nouel prismatic | 750—1000 | 1400—1850 |

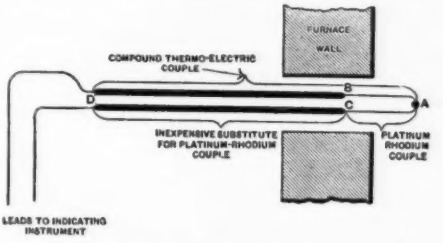
* The upper limits of some of these pyrometers are much above those here indicated—in some cases, as the Féry radiation instrument and the bolometer, there is no theoretical higher limit. The ranges here given are, so far as data have been obtainable, those within which reasonably accurate results are to be had in industrial service. Certain of the instruments named are sometimes made for laboratory use with higher and lower limits. The Holborn-Kurlbaum instrument is the German form of the Morse, and its range is the same.

† The bolometer, especially in its improved form, is a laboratory instrument capable of measuring infinitesimal changes in temperature, and has an unlimited theoretical range. A change as minute as the millionth part of a degree can be measured with it. In the improved form it consists essentially of a pair of differential platinum thermometers made of very narrow strips of exceedingly thin foil, one of which is completely blacked and the other bare, both enclosed in a hermetically sealed tube. An indicator of the Callendar type is generally used.

tools, adequate means for temperature guaging and reduplication are of prime importance.

A good many instruments and devices have been brought forward for gauging temperatures, especially temperatures above those for whose measurement the spirit or mercuric thermometer is available. Those at present in use which are of value in connection with industrial processes are included in the conspectus here presented.

Not all the instruments classified in the table are suitable for use in connection with the treatment of steels, and others can be used to a limited extent only. Thus the mercurial thermometer, when of suitable form, can be used for gauging the temperature of the oil tempering bath. When so used it needs to be made of specially heavy glass, well annealed, and preferably the tube above the mercury filled with an inert gas under great pressure.



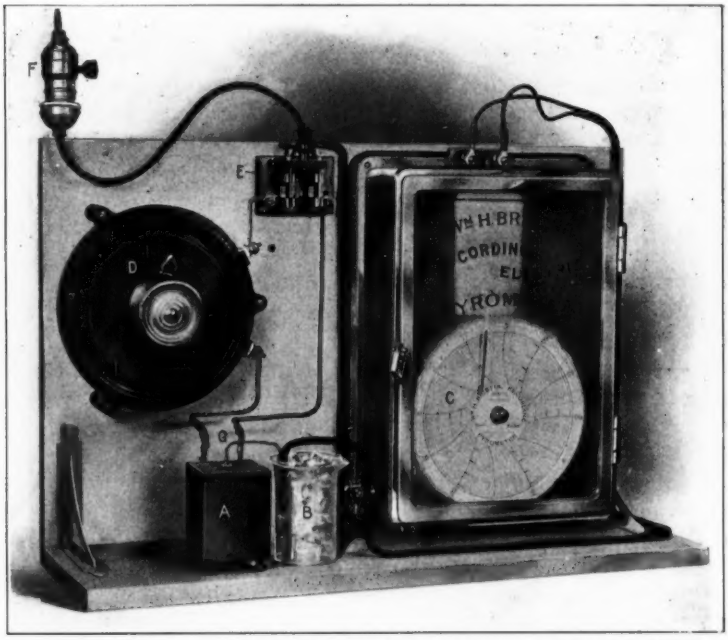

BRISTOL COMPOUND THERMO-ELECTRIC COUPLE FOR HIGH RANGES OF TEMPERATURE.

"Sentinel" pyrometers or temperature cones strictly speaking are not pyrometric, for there is no scale, and each cone can be used but once. They are made of metallic alloys or mixtures or earths and the like, so proportioned that when a given cone reaches a predetermined temperature it fuses or melts down. They are useful therefore in indicating when desired temperatures are reached, and by using pairs selected for the purpose, they can be made to indicate the maximum and minimum temperatures within which a process or treatment must be carried on. Thus if a tool is to be heated to somewhere between, say, 1,025 and 1,050 degrees C., two cones, one of which fuses at the lower temperature and the other at the higher, are placed in the furnace while the heat is going up. When the first cone melts down, the tool is introduced. By watching the second cone and regulating the furnace when there are signs of the cone melting, the temperature can be maintained below the permitted maximum. It is well to introduce cones of the first kind from time to time so as to insure keeping the temperature above the minimum. This method of course is rather tedious, and is not permissible as a regular thing in commercial work. The "sentinels" are very useful as a check upon the regular pyrometer, and also upon the judgment of the operator when tools are hardened without such an instrument.

Some sixty different grades, giving a range from about 590 to 1,975 degrees C., or 1,095 to 3,520 degrees F., are commercially obtainable.

The most usual method of gauging temperatures of materials undergoing industrial processes is to insert in the furnace, fire chamber, or other containing receptacle, the so-called "fire end" of any one of several types of pyrometers, the temperature (in the case of the electrical instruments) being indicated or recorded at a greater or less distance away, as may be expedient. In expansion instruments the indicators of course are attached directly to the stem, as in the water-current and the Brown platinum pyrometers. These instruments are based on the same principle, the former having its non-platinum parts cooled by a current of water so as to adapt it for continuous use. The latter is quite durable but is not adapted for continuous use, the stem or fire end being exposed to the furnace heat only long enough to allow the indicator to register the maximum, the instrument being withdrawn before the iron frame can be injured or the platinum impaired.

Le Chatelier seems to have been the first to perfect an electrical



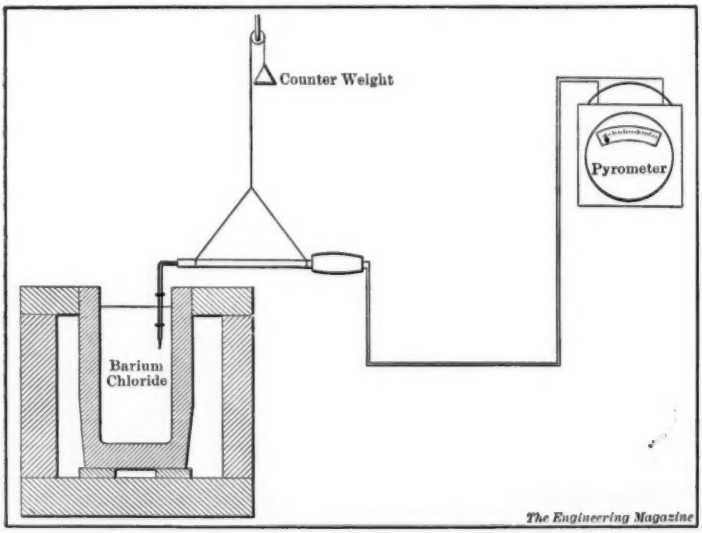

BRISTOL LABORATORY ELECTRIC FURNACE WITH, RECORDING ELECTRIC PYROMETER.

heat gauge applicable to industrial processes involving very high temperatures, in his thermo-couple electric pyrometer; and instruments of this type are most frequently used in connection with the treatment of high-speed steels. Several different makes are on the market, varying in excellence, reliability, and endurance. All, however, are based on the principle that when one junction of a thermo-couple, that is, of a continuous circuit composed of two different kinds of conductor, is heated while the other remains at a constant normal temperature, a feeble electric current is set up which varies (more or less regularly according to the materials constituting the thermo-couple) with the temperature to which the "hot" junction is exposed. The current of course can be measured by means of a delicate galvanometer, and the relations between the strength of current and the temperature of the junction having been determined, the deflections of the galvanometer needle may be converted into temperature indications. Owing to the "extra currents" and other disturbing elements found in pairs of most materials otherwise suitable for the purpose, and likewise because of the necessity of using elements capable of withstanding extremely high temperatures, the thermo-couple material must be selected and manufactured with extreme care. Most often, for the determination of such high temperatures as are involved in high-speed steel treatment, the couple is constituted of platinum and a platinum-rhodium alloy, though nickel-chrome steel and other nickel alloys also are used.

HOSKINS PYROMETER WITH EXPOSED COUPLE.
Hoskins Mfg. Co., Detroit.

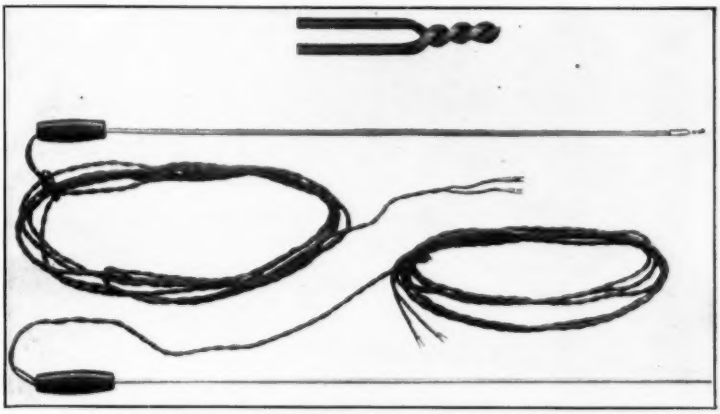
The heat resistance of these elements is very high, making it possible to expose the instrument, when made in the best form, to temperatures up to 1,600 degrees C (2,920 F.) and even above, for short periods of time. This is considerably above any temperature required in the making of tools, 1,400 C. (2,550 F.) or thereabout being the highest usually required. At these temperatures however the fire ends deteriorate with greater or less rapidity, and are easily

broken afterward. In order to prolong their period of accuracy and permanency they are usually protected by being enclosed within porcelain, fire clay, or other heat-resisting material (a combination of asbestos and carborundum, in the case of the Bristol instrument); but these frequently crack and crumble, and it is necessary to check the instruments at intervals against standards of known permanency, to insure consistency in the readings, if not accuracy. It is shown hereafter that absolute accuracy—that is, the indicating of the absolute temperature—is less essential than consistency; and so, if an instrument has departed from its calibration, if the variation be within reasonable limits, allowance can be made for this if the extent



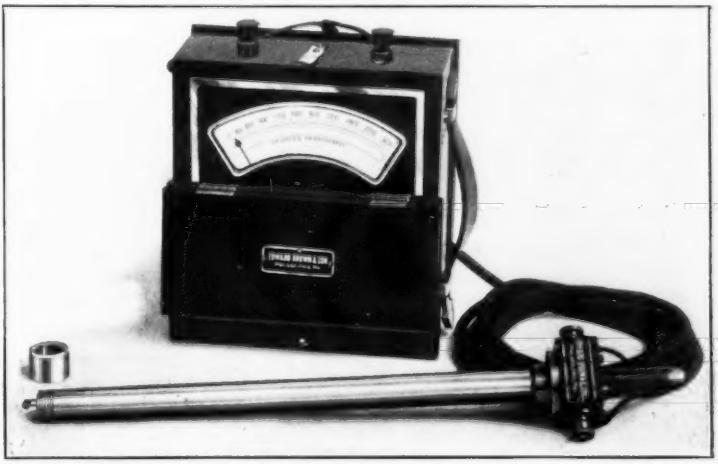

SUGGESTION FOR USE OF PYROMETER WITH BARIUM-CHLORIDE HARDENING BATH.
Hoskins Mfg. Co., Detroit, Mich.

is known. When the departure has reached an amount where the indications no longer are reliable, of course the instrument must be no longer used. A recent improvement in pyrometers of this type consists in making the fire end compound, only that portion actually exposed to the high temperature being of the precious metals. This reduces the expense of renewals considerably, while the readings are sufficiently accurate for the present purpose. Another development is the Hoskins thermo-couple, which is made of comparatively inexpensive alloys that withstand the required high heats apparently indefinitely, while at the same time they are made of wire heavy enough

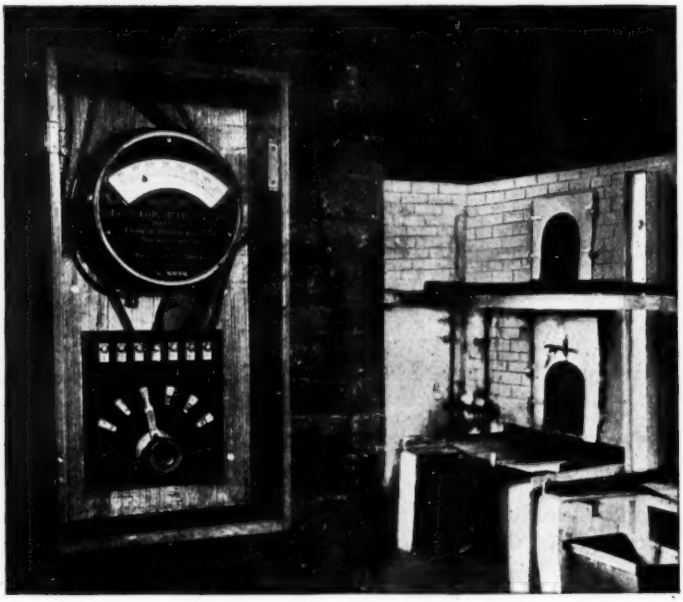


HOSKINS STANDARD FIRE END, STANDARD THERMO-COUPLE WITH HANDLE AND LEADS, AND NEW NICKEL SHEATH THERMO-COUPLE COMPLETE.
The fire end is made of heavy alloy wires twisted and welded. Hoskins Mfg. Co., Detroit.

to require no protection and to allow of considerable rough usage without detriment. The fire end junction, being exposed directly to the temperature to be measured without the intervention of protecting tubes or covers, responds quickly, and there is little or no lag in the indication. A modified form of this instrument has one element in the form of an asbestos-wound wire enclosed within, and having a junction with, a nickel tube which forms the other element.



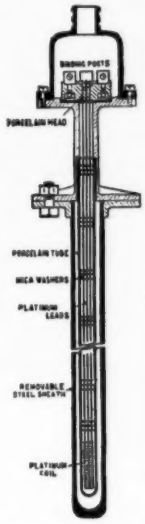
THERMO-COUPLE PYROMETER ENCLOSED IN STEEL TUBE, AND INDICATING INSTRUMENT.
Edward Brown & Son, Phila.



ELECTRIC PYROMETER FIRE ENDS CONNECTED WITH A BATTERY OF FURNACES.
A switchboard and indicator are placed at a convenient central point. Edward Brown & Son, Phila.

It is well enough, and in the case of most of these instruments necessary, to provide an iron-pipe covering, perhaps of ordinary gas pipe, closed at the inner end so as to form a well, not only for the protection of the fire end, but to prevent unnecessary and often detrimental air currents. Inasmuch also as the correct registering of the temperature under observation depends upon the "cold" end of the couple being near the temperature for which the instrument is calibrated (usually about 25 degrees C. or 75 F.), this end should be out of the range of direct radiation of the furnace, or other sources of temperature variation. The Bristol instrument has an arrangement whereby the cold end is kept near the floor; in case still greater accuracy is required, a compensator is placed in the circuit to preserve the calibration practically correct. Unless the atmospheric temperature varies considerably from that above given (25 C.) allowance can be made for it in reading the indicator. This allowance is governed by the design of the instrument, and is usually furnished by the maker. At least one indicator on the market utilizes a multiple scale whereby the allowance is made automatically by reading the scale nearest cor-

responding to the atmospheric temperature, as shown by a mercurial thermometer provided for the purpose. Theoretically the temperature of the cold end should be at zero; and in laboratory work, and in certain industrial operations where much refinement is necessary, an "ice bobbin" is utilized for maintaining this condition. In ordinary industrial processes, such as steel hardening, where the length of the elements is sufficient to allow the cold junction to be moderately near the limits indicated, slight variations may be disregarded.




CONSTRUCTION OF ELECTRICAL RESISTANCE PYROMETER. Taylor Instrument Co.

The resistance type of electrical pyrometer is also used to some extent in hardening high-speed steels; and for all temperatures below 850 C. (1,600 F.) this is perhaps the most accurate type, suitable especially where a very open scale is desired. It depends for its action upon the variation in the electrical conductivity of a platinum wire or foil, according to the temperature to which it is exposed. This variation is practically constant and when measured by an indicator constructed on the principle of the Wheatstone bridge, can be easily reduced to temperature units—or most usually, read off directly on a temperature scale to which the indicator has been calibrated. The indicators and recorders are cumbersome and much more expensive than those for thermo-couple pyrometers of the same range. The latter are better adapted to measuring hardening temperatures because the resistance instruments will not stand long exposures to the intense heats required, their maximum for even short periods being only 1,200 C., or 2,200 F. For the matter of that, it is desirable that neither kind be exposed unnecessarily; and especially when enclosed in porcelain or similar protective cylinders they must be heated up gradually. The fire ends crumble and deteriorate quite rapidly enough with careful usage. Besides being unsuited for continued use at temperatures above 850 C. (1,600 F.), the cost of the resistance fire ends, as well as the indicators or recorders, is very much higher than that of the thermo-couple type.

Two other pyrometers have been used in connection with hardening high-speed tools, with good results—the water-current and the Uehling pneumatic. Both have all parts exposed to the fire, except those made of platinum, cooled by circulating water. Their accuracy and permanency therefore are much greater than those of most other forms of fire and temperature gauges.

# ECONOMIES IN THE MANUFACTURE OF IRON AND STEEL.

*By G. B. Waterhouse.*

## I. THE GAYLEY DRY BLAST PROCESS.

The American steel industry is a center of great interest at present because of changing conditions, and of the adjustment of costs, and hence adaptation of methods, to a possible new range of prices. Several large factors and some minor ones are entering the manufacturing problem with rapidly increasing effect and probably large ultimate economic importance. The most important of these are the utilization of blast furnace gas, the Gayley dry-blast process, the manufacture of slag cement, and the use of processes for concentration of iron ores. The first of these has already received a good deal of attention in our pages. Dr. Waterhouse, whose connection with the industry gives him unquestioned rank as an authority, will follow this article with a second upon the manufacture of slag-cement, and the fourth heading will be taken up by another leading specialist.—THE EDITORS.

IT is the purpose of the following articles to describe and discuss two of the most important lines along which economies are being effected in the iron and steel industry. These are the Gayley dry-blast process, and the utilization of blast-furnace slag. It is becoming more and more apparent that the industries must carefully consider their methods, and their by-products. The time of somewhat recklessly using raw materials is rapidly passing, and the methods that prove most economical in practice are coming more than ever to the front. Much attention is also being paid to the by-products of the different industries, and along this line there is no doubt the next few decades will see wonderful advances.

The first subject to be taken up is that of the application of comparatively dry blast to the manufacture of iron. It is usually spoken of as "the Gayley dry-blast process," and its chief development has been in connection with the blast furnace.

### HISTORY OF THE PROCESS.

The first public notice of the process was given in a paper read by Mr. Gayley before a meeting of the Iron and Steel Institute, held in New York, October, 1904; it was entitled "The Application of Dry Air Blast to the Manufacture of Iron." Mr. Gayley was at that time first vice-president of the United States Steel Corporation, and also president of the American Society of Mining Engineers, so that the

matter was at once brought prominently to the notice of the technical men both of Great Britain and America.

This is hardly stating the case, for as the Iron and Steel Institute is international in its membership, practically the whole technical world became acquainted with the subject. The paper showed that great uniformity had been reached in three of the four raw materials used in iron manufacture—namely, the ore, the coke and the limestone; but that the remaining material—the air—varied greatly in its content of moisture, not only from day to day, but even at different times in the same day. This renders the process an uncertain one, and dependent on the caprice of the atmosphere. This point was emphasized and fully brought out, and then an account was given of the experiment carried out at the Isabella Furnaces, at Etna, near Pittsburgh; an experiment on a grand scale whereby the air used in the blast was also made uniform. By means of refrigeration the moisture was held practically constant, and at a very low limit.

Dry blast was applied to Furnace No. 1 of the Isabella plant on August 11, 1904, and was found to cause great economies. The production of iron was increased about 24 per cent and at the same time the coke required to produce one ton of iron was reduced about the same amount. The percentage of the flue dust was reduced from 5 per cent of the ore charged, to less than 1 per cent, and owing to the greater density of the cold dried air, the blowing engines could supply the necessary amount of oxygen with a smaller number of revolutions per minute, or in other words, considerably less power was consumed in the blowing-engine room.

The paper and the results obtained attracted wide attention. It was followed at the May meeting of the Iron and Steel Institute, 1905, by a further paper by Mr. Gayley, giving the results obtained at the Isabella Furnace from November, 1904, to March, 1905, inclusive. They showed that the good effects were continued and will be more fully spoken of later. The benefits of the process were now thoroughly established, and blast-furnace men began to take up the matter in earnest.

In March, 1906, it was announced that the Warwick Iron & Steel Co., of Pottstown, Pa., were about to install a system capable of supplying dry blast for their two furnaces making merchant iron. It was felt that this would be an ideal place in which to try the process, as the plant was located in the Schuylkill valley, where the moisture in the summer was frequently as high as 12 grains to the cubic foot. An excellent paper, describing the installation and giving the results

obtained, was read by Mr. E. B. Cook before the American Institute of Mining Engineers, at their October meeting, 1908.

In March, 1906, a paper was read by Mr. C. A. Meissner before the same institute, bringing the results obtained at the Isabella furnaces down to date, and discussing most of the points brought out by other writers and critics.

In August of the same year an order was made public from Messrs. Guest, Keen and Nettlefolds, for the Dowlais Iron Works, at Cardiff, South Wales, this being the first company in Europe to take up the process. A little later in the year, in October, a license was issued to the Brier Hill Iron & Coal Co., Youngstown, Ohio, which was the first company to obtain a license west of Pittsburgh. Since that time licenses have been issued to many other companies, including the South Chicago plant of the Illinois Steel Co., the Toledo Furnace Co., Toledo, Ohio, the Federal Furnace Co., of Chicago, the Northwestern Iron Co., of Mayville, Wis., the Youngstown Sheet & Tube Co., of Youngstown, the Cleveland Cliffs Iron Co., of Marquette, Mich., and one plant in Canada, the Hamilton Iron & Steel Co., of Hamilton, Ont.

At the first mentioned plant, the dry blast has also been tried in the Bessemer Department and an expenditure has been authorized to make it a permanent installation.

## The Process.

The process in general consists of desiccating air, and applying this dried air to the blast-furnace operations. The method of desiccation chosen by Mr. Gayley is that of cooling the air below the freezing point of water, and thus freezing out the greater part of the moisture, the cold dry air then going to the blowing tubs of the blowing engines. Ammonia was chosen as the refrigerating agent, but advantage is not directly taken of the expansion of ammonia, because of the great danger to anyone in an air-refrigerating chamber if a pipe should break or a joint leak. The ammonia therefore first cools a brine solution, consisting, in the case of one plant, of sea water, but in other cases of a calcium-chloride solution with a specific gravity of 1.21. The cold brine then passes through pipes placed in refrigerating chambers. The air for the blast passes through these chambers. On the lower pipes the moisture is deposited as water, and on the upper ones as frost, and the air passes to the blowing engines at practically the freezing point of water, and with a uniform amount of moisture.

It has been noticed by blast-furnace men for very many years that their furnaces worked better in crisp dry weather, and that a better tonnage was obtained in the winter months when the moisure was lower, than in the summer months when the humidity was high. In some places, as at the Warwick plant, Pottstown, Pa., a careful record was kept of the humidity and attempts were made to meet the changes by altering the burden of the furnace. In Table I are shown the figures obtained throughout the year on Furnaces 2 and 4 of Schneider & Co.'s plant at Creusôt, by M. Divary. They illustrate very clearly the changes that take place between the winter and summer months.

TABLE I. RESULTS AT CREUSÔT.

| Month. | Moisture. Grammes per cubic metre. | Increase in Fuel Consumption. Kilos per ton. | Average Furnace Product. Tons per 24 hrs. |
|---|---|---|---|
| January | 6.3 | 0 | 90.5 |
| February | 6.6 | 10 | 88.7 |
| March | 7.6 | 13 | 87.2 |
| April | 7.8 | 47 | 81.2 |
| May | 10.0 | 56 | 78.3 |
| June | 11.7 | 103 | 75.7 |
| July | 13.0 | 133 | 70.0 |
| August | 12.0 | 90 | 76.6 |
| September | 9.3 | 55 | 90.0 |
| October | 8.0 | 28 | 86.0 |
| November | 7.6 | 25 | 86.5 |
| December | 7.0 | 35 | 88.5 |

In the United States the changes in moisture percentage are even more marked, especially in the localities where most of the blast furnaces are situated. In Pittsburgh, where Mr. Gayley carried out his experiments, a careful record made for a year, at the ordinary ground level, showed a variation from 2.8 grains per cubic foot in January, which was the lowest, to 7.3 grains per cubic foot in June, which was the highest. These amounts are not regular in each month, but as has been stated, vary greatly from day to day, and also during the same day.

It was to do away with this irregularity that Mr. Gayley conceived and carried out this process, one that has had results far exceeding those that were originally estimated. By it as has been stated air is furnished to the blowing engines, and from them to the furnace, very low in moisture, practically constant from day to day, and varying very little from month to month.

Great advantage necessarily comes from the avoidance of blowing in from 140 to 365 gallons of water per hour into the furnace with the blast, but the greatest gain of all comes from this uniformity.

## Description of the Plant.

A typical refrigerating plant is that erected at the South Chicago plant of the Illinois Steel Co. to supply 130,000 cubic feet of air per minute. It is located in special buildings erected for the purpose, consisting of a main building and a lean-to.

On the first floor of the main building, which is 102 feet long by 53 feet wide, and 40 feet high, there are four refrigerating machines of 300-tons refrigerating capacity each. The installation was erected by the Vilter Manufacturing Co., of Milwaukee, Wis., with the exception of the pumps, which were from the Fred M. Prescott Manufacturing Co., also of Milwaukee. The refrigerating machines are of the duplex horizontal type, each one being a cross-compound condensing engine. Two ammonia compressors are placed opposite the high- and low-pressure steam cylinders. The steam cylinders are 24 x 46 inches with a 36-inch stroke, and the ammonia compressors are 18 inches in diameter with a 36-inch stroke. Readily accessible suction and discharge valves are placed in each cylinder head of the compressors. The building is spanned by a traveling crane. The gas passes through oil traps, one for each machine, and enters the condensers on the second floor. These are grouped in 25 stands, twelve pipes high, and are of the double-pipe variety, 2-inch pipes 18 feet long, having a 1¼-inch pipe passing through them for the passage of the cooling or condensing water. Division is made into four units, but by means of suitable connections and valves either two machines or all of them may be used in combination with a part or all of the ammonia condensing system.

The liquified gas is collected in four receivers located near the oil traps, and is carried through individual pipes to the cooling apparatus. Here the liquid ammonia is evaporated by means of the heat from the circulating brine solution used afterward for cooling the air. The brine consists of a saturated solution of calcium chloride. The boiling point of the ammonia at the pressure used is from 5 to 10 degrees F.

The cooling apparatus is situated in a lean to adjoining the engine room, 68 feet 4 inches long, 58 feet 8 inches wide and 25 feet high. It is well insulated with a double lining of cork board 2 inches thick. The coolers are also of the double-pipe variety consisting of 3-inch pipes with 2-inch pipes passing through them. The estimated cost of the complete installation, including the buildings, the refrigerating equipment, the pumps, the brine and ammonia, the piping, the insu-

lating material, and the engineering and miscellaneous items, is $285,000.

Another typical plant, and one that has already rendered excellent service, is that of the Warwick Iron & Steel Co., Pottstown, Pa., capable of supplying 70,000 cubic feet of air per minute, sufficient for their furnaces Nos. 1 and 2. This plant, like most of the dry-blast plants, was designed and installed by the York Manufacturing Co., of York, Pa. It is exactly similar in type to the one mentioned before. Ammonia, liquified by pressure, expands in pipes surrounding smaller pipes, carrying calcium chloride solution. This solution is cooled below the freezing point of water, and is conducted through coils of pipes in refrigerating chambers. The air passes through these chambers and deposits the larger part of its moisture before going to the blowing engines. The ammonia is compressed in five vertical single acting compressors, each of about 220 horse power, and 175-tons refrigerating capacity. Only in summer is the entire capacity needed—in the winter months one compressor to each furnace is sufficient. A view of the engine room is shown in Figure 1, and Figure 2 gives a view of the condenser room. The brine coolers are of the double-pipe class, the ammonia expanding in a 3-inch outer pipe, the brine solution passing in the opposite direction through a 2-inch inner pipe. Through these coils and through the coils in the refrigerating chamber the brine solution is forced by one of two fly-wheel pumps. The refrigerating chamber is divided into seven sections by partition walls and doors. The coils of one section can be washed clean of frost, without affecting the others or increasing the moisture in the treated air. The brine passes through these chambers in 57 miles of 1¼-inch diameter wrought-iron pipe. A large Sturtevant fan furnishes the air for the refrigerating chamber at a slight pressure, to overcome the friction of the coils.

With a product of 720 tons of iron a day, and running all the ammonia compressors, the labor cost for the plant is 2½ cents a ton. Estimating that ⅓ of the ammonia is lost per year, which is very excessive, this amounts to 1 cent a ton, giving a total of 7 cents a ton. It was estimated that 10 cents a ton would be required for operation and maintenance. Five per cent is found to be sufficient for depreciation. No charge is made for steam, as the reduction in the revolutions of the blowing engines spares enough power to run the refrigerating machinery, brine pump, and fan. A very similar plant is now being erected at the Toledo Furnace Co. plant, Toledo, Ohio, to furnish 70,000 cubic feet of air per minute, at an estimated cost of $250,000.00.

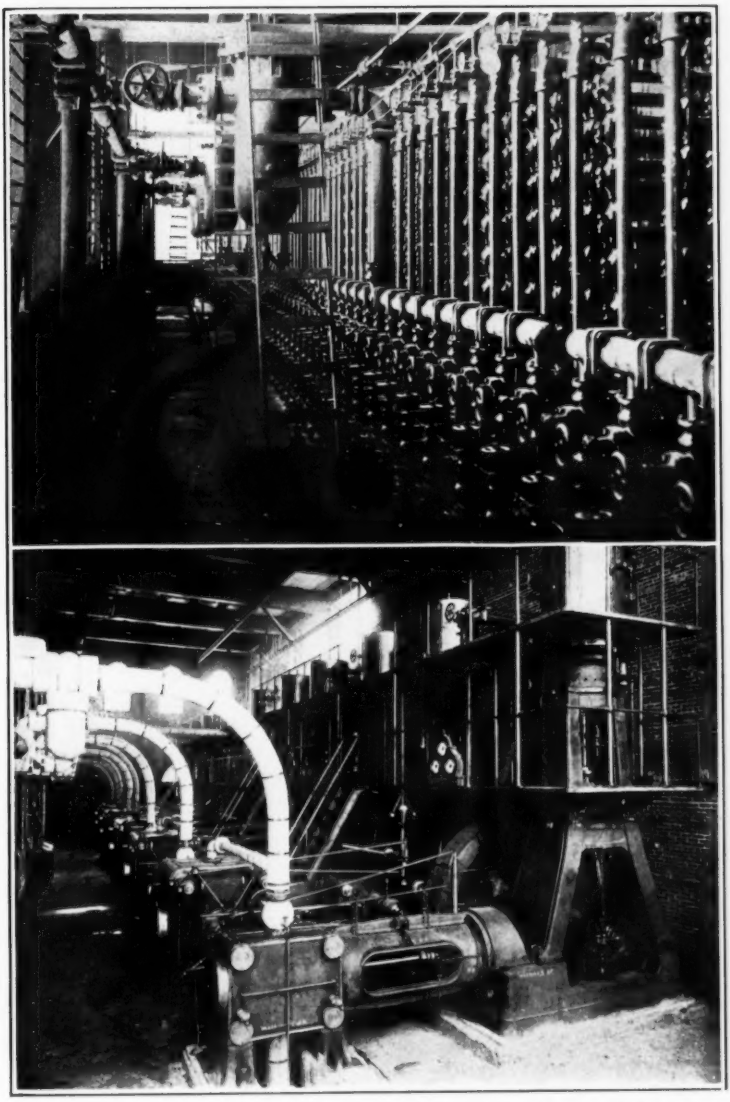
## Results Obtained.

The remarkable results obtained at the Isabella furnaces, from August to September, 1904, have already been mentioned. In the early part of August, using natural air, the average daily product was 358 tons with a coke consumption of 2,147 pounds per ton. The latter part of August and the beginning of September, using dry blast, the average daily tonnage was 447 tons, with a coke consumption of 1,726 pounds per ton. Considerable exception was taken to these figures abroad, the chief criticism being that the furnace was working badly before the dry blast was applied.

Mr. Gayley's next paper gave the results obtained on the same furnaces from November, 1904, to March, 1905—that is, through the winter months, when the least benefit was to be expected. In November the average moisture was lowered from 1.99 to 1.02 grains per cubic foot. No. 1 furnace, on dry air, gave a daily product of 447 tons with a coke consumption of 1,816 pounds per ton. No. 3 furnace, with the same ores, fuel, and flux, using ordinary air, and with blast at 100 degrees F. lower temperature, gave only 386 tons a day, with a coke consumption of 2,279 pounds per ton. In December, No. 1 furnace, still on dry air, gave 455 tons per day, using 1,823 pounds coke per ton. From December 1 to 22, No. 3 furnace, on ordinary air, made 400 tons a day, using 2,309 pounds coke per ton. From December 23 to 31, rather more than ⅓ of dry air was used in the blast, when the product increased to 461 tons, and the coke consumption dropped to 2,140 pounds.

In January, the month with the lowest humidity, the dry blast was taken from No. 1 and applied to No. 3 furnace. This was to determine the economy on another furnace. The response was prompt and efficient, and clearly demonstrated the economy of the process in the dry months. From January 1 to 10, No. 1 furnace on dry air made 428 tons per day with 1,825 pounds coke per ton. A few days were necessary to allow for the changing conditions of the blast, and from January 15 to 31, with ordinary air, she made 414 tons per day, but needed 2,340 pounds of coke. The change with No. 3 furnace brought about the following results. January 1 to 10, ordinary air, the daily product was 410 tons, coke consumption 2,351 pounds; from 15 to 31, with dry air, it was 432 tons per day, with a coke consumption of 1,811 pounds per ton.

It had been thought by many metallurgists that the use of dry blast could be dispensed with in the winter. The next month, February, was an excellent one to test this point, for then the moisture



FIGURES 1 AND 2. ENGINE ROOM AND CONDENSER ROOM, WARWICK IRON & STEEL CO., POTTSTOWN, PA.

For refrigerating 70,000 cu. ft. of air per minute to remove moisture by the Gayley dry-blast process.

in the ordinary air sometimes ran lower than in the dried blast. The dry blast, however, still showed a very marked improvement, especially with regard to coke economy, for about as much iron was made with 433 pounds less coke per ton.

In March the plant was shut down several days owing to floods, and the furnaces were banked. No. 3 with dry air, on starting up, responded more quickly and gave iron of grade in one day, whereas it took three days for No. 1 furnace. These results together with other data are given in Table II, most of the figures being averages.

TABLE II. RESULTS AT ISABELLA FURNACES.
November, 1904, to May, 1905.

| Date. | Furnace. | Blast. | Daily Product. | Coke Consumption. | Blowing Engine. Rev. per min. | Temp. Hot Blast. Degrees F. |
|---|---|---|---|---|---|---|
| Nov., 1904... | 1 | Dry | 447 | 1816 | 96 | 854 |
| Nov. ..... | 3 | Ord. | 386 | 2279 | 111 | 750 |
| Dec. ..... | 1 | Dry | 455 | 1823 | 96 | 877 |
| Dec. 1-22... | 3 | Ord. | 400 | 2309 | 111 | 785 |
| Dec. 23-31... | 3 | ⅓ Dry | 461 | 2140 | 111 | 785 |
| Jan. 1-10.... | 1 | Dry | 428 | 1825 | 96 | 869 |
| Jan. 15-31.... | 1 | Ord. | 414 | 2340 | 111 | 771 |
| Jan. 1-10.... | 3 | Ord. | 410 | 2351 | 111 | 716 |
| Jan. 15-31.... | 3 | Dry | 432 | 1811 | 96 | 802 |
| Feb. ..... | 1 | Ord. | 424 | 2248 | 111 | 800 |
| Feb. ..... | 3 | Dry | 412 | 1815 | 96 | 784 |
| Mar. ..... | 1 | Ord. | 411 | 2274 | 111 | 850 |
| Mar. ..... | 3 | Dry | 405 | 1837 | 96 | 784 |

Mr. Meissner's paper of February, 1906, brought the results down to date, and gave tables showing that an increase in the temperature of the blast was not alone sufficient to bring about the economies.

These results, obtained with the Isabella furnaces, as well as being markedly instructive, are of great historical interest. Probably the best records of other results are those obtained at the plant of the Warwick Iron & Steel Co., previously mentioned. Here the furnaces were old, and with normal working would have been blown out. It was hoped to prolong the life of their No. 2 furnace sufficiently to complete certain profitable contracts for basic iron. The specifications are within rather narrow limits, and call for:

| | |
|---|---|
| Silicon under | 1.00 |
| Sulphur | .05 |
| Phosphorus | 1.00 |

This end was successfully attained; and at the same time, even with the bad condition of the furnace, a far greater percentage of the foundry grade was made than before. To give some details; the furnace had been in blast nearly three years and made more than 500,000 tons of iron. On August 8, 1907, two compressors being

ready, dry blast was applied. The moisture was lowered from 7 grains to 5 per cubic foot, on the next day to 4, and on the next to 3. The temperature of the iron and slag increased greatly, and the burden had to be constantly increased to keep the silicon below 1.0 per cent. On account of her imperfect lines the furnace did not work well and was blown out December 27. A partial record is given below:

TABLE III. FURNACE No. 2, WARWICK I. & S. Co.

| Date. | Tons per week. | Coke per ton, lb. | Percentage Basic Iron |
|---|---|---|---|
| August, 1907 | 2649 | 2452 | 69.0 |
| September | 2638 | 2503 | 78.2 |
| October | 2927 | 2501 | 82.2 |
| November | 2735 | 2339 | 80.4 |
| December | 2880 | 2261 | 88.5 |
| April, 1904 | 2660 | 2716 | 54.0 |
| May | 2634 | 2745 | 46.0 |

The last two lines give contemporaneous records, using ordinary air, and with the furnace in good condition. The averages show a monthly increase of iron of 132 tons, being 5 per cent; a decrease in coke consumption of 321 pounds per ton, being 11.7 per cent; and an increase in percentage of grade iron from 50.0 to 81.9. It is said that through this short campaign the entire cost of the installation was met, because of the contracts being filled, and the greater percentage of merchantable iron made.

Furnace No. 1 was making high-silicon foundry iron, and was also in bad condition. The dry blast was only on 45 days; the daily product was increased about 10 per cent, and the quality somewhat improved. After relining, the dry blast was again applied; in several successive weeks the record has been nearly 1,700 tons week, with less than 1,900 pounds coke per ton, and with a blast temperature below 900 degrees F. The best record with ordinary air, on foundry iron, is 1,016 tons per week with 2,633 pounds coke per ton, and a blast temperature of 1,016 degrees F. They feel that they are saving 400 pounds of fuel per ton of iron, and making 350 tons more iron per week with a lower blast temperature, and using a much more refractory ore mixture. Later results show even more marked improvement, the same furnace in November, 1908, on foundry grade, giving 95 per cent. of the grade desired and making 1,449 tons per week, with 2,181 pounds of coke.

Finally, some results may be given from the installation at Cardiff, South Wales. Here the furnace has been in blast one year, on a new lining, and is in good condition to give excellent results. When operating for increased output as in the main consideration,

the tonnage was increased 26.4 per cent and the coke consumption lowered 13.4 per cent. When striving for a decreased coke consumption, the tonnage increased 14.1 per cent and the coke consumption decreased 18.4 per cent.

TABLE IV. RESULTS AT CARDIFF, SOUTH WALES.

| | Tonnage weekly. | Coke per ton. |
|---|---|---|
| First 50 weeks, natural air | 2001 | 2278 |
| Dry air, operated for increased output, 5 weeks | 2530 | 1972 |
| Dry air, operated for economy of fuel 4 weeks | 2286 | 1857 |

The examples given above are sufficient to illustrate the large increase in tonnage that is obtained, and the economy of fuel. Either of these advantages may be striven for at the expense of the other, depending upon the conditions at a given plant. Probably the greatest advantage of all, especially for furnaces making merchant iron, is the greatly increased certainty with which iron of a desired grade can be made.

This is well brought out in the case of the Pottstown plant, even when the furnace was in bad condition, and particularly so after relining. Similarly good results have been obtained at the E. and G Brooke Iron Co., Birdsboro, Pa.

## THEORETICAL CONSIDERATIONS.

Many theories have been advanced to account for the splendid results obtained. The uniformity of practice, as seen in the control of the grade of iron produced, necessarily comes from the control exercised over all four of the raw materials. The decrease in coke consumption, that is, the economy of fuel, is not so easily explained. The moisture entering the furnace with the blast requires a great deal of heat for its dissociation. Careful calculations show that this amounts to about 3 per cent, so that drying the air would give a saving of about this amount. The great saving observed in practice comes about from the fact that in ordinary furnace operations an excess of fuel has to be constantly maintained to care for the sudden changes coming in the blast furnace conditions, these changes being very largely due to the abrupt changes in the moisture contents of the air. With the dry blast, also, the zone of fusion in which the greatest part of the work is done is held more steadily in one place, and is at a higher temperature than with ordinary blast, which brings about better combustion of the fuel.

Careful measurements have also proven that the waste gases pass away at a lower temperature, which necessarily means that better heat economy is being attained in the furnace.

The reason for the marked increase in metal production was also by no means clear. The most scientific theory is that advanced by Mr. J. E. Johnson, Jr., and by Professor Howe. They maintain that the useful work of the furnace is done only above a certain critical temperature, which may be placed at about 1,300 degrees C. The temperature of combustion with ordinary blast is about 1,860 degrees, so that there are 560 degrees available to carry on the furnace operations. With dry blast the heat of combustion is about 1,965 degrees, which gives 665 degrees available, equaling about 19 per cent more useful heat, and consequently giving this increase in production.

Another explanation is that the saving of about 3 per cent which the removal of the moisture brings about, is saved to the hearth alone. One-fourth of the heat value of the coke charged is available for the hearth; another fourth reduces the ore, and the remainder is found in the gases. The 3 per cent, being a saving to the hearth, gives, therefore, a 12 per cent increase, and as the hearth is the one weak place, it increases the capacity of the furnace about 12 per cent.

The "critical temperature" theory appears to fit the facts thoroughly, for it is well known that in many operations the reaching of such a critical temperature is the great necessity.

Concerning the future of the process, there seems no doubt of its success. It has been thoroughly tried in different localities. Its advantages have been proven with furnaces after relining, when they were in excellent condition, and when so far worn as to be no longer worth running under ordinary conditions. In the hot summer months, with high humidity, its advantages appear most marked, but in the winter months, when the moisture is low, the records show almost equally favorable results. In the various localities, different ore mixtures and different fuels have been used; and the process has been in the hands of different organizations, but in every case has given the same far reaching economies.

It does not seem too much to say that in importance, the process ranks very close to the revolutionary one of Nielson's in 1828, namely, that of the hot blast and its application to iron manufacture.

# THE PROTECTION OF IRON AND STEEL FROM CORROSION.

*By Wm. H. Walker.*

Dr. Walker's article is based upon researches reported in a comprehensive paper to be presented at the May meeting of the Iron and Steel Institute. The subject matter is here selected, condensed, and adapted by the author for the specialized engineering audience made up by readers of the magazine.—THE EDITORS.

THE rapidly increasing use of iron and steel in almost every kind of construction work makes necessary a more perfect knowledge of the fundamental principles underlying corrosion and the modern methods of protecting such structures from decay; for, with the exception of occasional weakening due to what is commonly called the "fatigue" of iron, the active life of these structures is practically limited by the rate at which they corrode or rust.

While a tendency to corrode is a property inherent in iron and therefore always present, yet from the fact that under identical conditions of service some samples corrode much more rapidly than do others, it is evident that there is something other than the iron itself playing an important part in the phenomenon. The commercial material which we term iron is unique in that it is never in reality the pure metal (as copper, for example, is), but always a mixture of iron and certain alloys of iron with other elements with which it unites during the process of its manufacture. These alloys or compounds, moreover, when present even to a very minute extent, have a controlling effect upon the physical properties of the resultant product. When the iron is first reduced from its ore, these impurities are present in relatively large quantities, and are removed by refining processes, which if carried on with the iron in a plastic condition results in what we term wrought iron, while if during the process of refining the mass is continuously held in a molten condition, the material known as steel is produced. The iron of fifty years ago was made by the first process, and it cannot be denied that such material resisted corrosion better than much of our modern iron or steel.

There has been an endeavor on the part of some manufacturers who now use processes essentially the same as that formerly used, to attribute the value of the old product to the process, and to assert

that the output of a puddling furnace, for example, must be the more valuable because it was made in such a furnace. But while a product is in general a function of the process used in its making, it does not follow that the process alone can insure the value of the product, and that wrought iron will necessarily resist corrosion because it is wrought iron. Hence the futility of the discussion which has been going on for the last few years as to the relative merits of wrought iron and steel as to this particular property. We have plenty of good steel and bad wrought iron, and also bad steel and good wrought iron. Had the energy and time spent in this useless wrangle been devoted to a sincere endeavor to determine the factors controlling the rate of corrosion, the problem would now be nearer solution.

Before we can intelligently discuss this variation in the tendency of different samples of iron and steel to corrode, or inquire as to the methods of preventing such corrosion, it will be necessary to state briefly the fundamental principles underlying the phenomenon, and the conditions which must obtain in order that it may take place.

The substance, rust, is a combination of oxygen and iron usually associated with more or less water. Oxygen will not unite directly with metallic iron except at a high temperature, when it forms a dense magnetic mass such as mill-scale. In order for the union to take place at ordinary temperatures, the iron must pass into solution as an electrically charged atom called an ion. Every metal when placed in contact with water, has a certain tendency thus to pass into solution. This tendency to escape into the water is known as solution pressure, and varies with the metal. In one like sodium, this pressure is so great that instant solution occurs when the metal comes in contact with water, while in the metal platinum the solution pressure is negative in value. In passing into solution, the metallic particles change from an atomic condition to the ionic condition, and in so doing, assume a positive charge of electricity, leaving the metal itself negatively charged. There will thus be formed around the metal an electrolytic double layer and the action will cease. If, however, there be present in the water another ion which has a less solution pressure than the metal under consideration, such ion will pass from its ionic condition to its atomic condition and separate out upon the first metal, giving up its positive charge of electricity thereto. An electric current will therefore pass through the solution from one point on the metal to the other, destroying the electrolytic double layer and causing the solvent action of the metal to be continued.

When a piece of iron is immersed in a solution of copper sulphate, for example, such a reaction takes place. The iron passes into solu-

tion, metallic copper plates out upon the metallic iron and an electric current flows from those places where the iron is passing into solution to those portions where the copper is plating out and through this copper to the iron again, although these points may be infinitely near together. If now, the bar of iron be placed in water instead of the copper-sulphate solution, a perfectly analogous reaction takes place, except that instead of copper separating out on the iron we now have one of the ions of which water itself is composed, viz., *hydrogen*, separating out on the iron and an electric current flowing as before. Water is composed, or breaks up into, the two ions—hydrogen, which carries the positive charge, and what is termed the hydroxyl ion, which carries an equivalent negative charge. It happens that there exists a very delicate test for the presence of the iron ion in the fact that potassium ferricyanide solution immediately forms therewith a bright blue color; while, on the other hand, there is an organic substance known as phenol phthalein, which becomes intensely red in the presence of hydroxyl ions. If, therefore, a piece of iron be placed in a water solution containing potassium ferricyanide and phenol phthalein, and which, to prevent convection currents, is thickened with a little ordinary gelatine, there should be formed a bright blue color at those points on the iron bar at which the iron is passing into solution, and a bright red color on those portions on which the hydrogen is plating out, leaving in the solution at that place an equivalent number of hydroxyl ions. These conditions are easily realized, and an experiment is shown in Figure I, where some ordinary wire nails have been placed in such a jelly. The dense portions are the blue zones at those points where iron is passing into solution and reacting with the ferricyanide, and the deeper portions are the red of the phenol phthalein where separating hydrogen has left the free hydroxyl ions. The flow of the current may be seen to be by preference from the *ends* of the nails, just as is the case with

FIG. I. CORROSION OF IRON IN WATER.

magnetic lines of force. The ends of the two nails running horizontal have been tipped with paraffin, which throws, as a rule, the point of corrosion into the middle of the nail.* The fact that iron in the presence of a phenol phthalein solution colored the same red was first noted by Dr. A. S. Cushman, of Washington, D. C., and was used by him to prove the presence of ferrous hydroxide in solution. This observation in my hands has resulted in this convincing proof of the first and important step in the corrosion of iron.

According to this conception, therefore, if a piece of iron be placed in water in the absence of air or other foreign material, iron should continue to pass into solution and hydrogen should continue to plate out in the form of gas; but this is not in fact the case. This solvent action in water proceeds but to a very slight extent and then practically stops, while when iron is placed in a copper-sulphate solution under similar conditions the action is continuous. But in the case of the copper, which plates out on the iron, we have a good conductor for the electric current which must pass from one point of the iron through the solution and the copper back to the iron again. The film of hydrogen which plates out on the iron in the second case, however, is not a conductor of electricity, but an insulator, and until it is removed the current cannot pass nor the action continue.

Since the presence of the polarizing film of hydrogen arrests the further solution of the iron, it is obvious that in order for the reaction to proceed, this hydrogen must be removed. The destruction of the hydrogen film in ordinary corrosion is accomplished by the oxygen of the atmosphere which is dissolved in the water. The action here taking place is a simple union of the hydrogen on the iron and the oxygen dissolved from the air, with the reformation of water. It follows from this that any substance which dissolves or reacts with hydrogen should accelerate corrosion. This is found to be in fact the case.

It was formerly thought that the action of oxygen as a factor necessary in corrosion was simply to oxidize the iron ions thrown into solution, and to precipitate them as rust. While it is true that this reaction does take place, and is indeed the most striking function that oxygen performs, it is in reality a secondary one, simply incidental to corrosion and not a necessary part of the action. Its real accelerating effect is due to the fact that it depolarizes the hydrogen which is set free by the reaction and separates out on the metallic iron.

Having now a conception of the mechanism by which iron corrodes, some important conclusions may be drawn.

* Inasmuch as pieces of iron having a uniform surface are desirable for this experiment, wire nails are preferred. Care must be taken, however, to see that they are free from adhering alkali.

Since corrosion can take place only when the deposited hydrogen film is continually destroyed, it follows that any agency that will increase the speed of the reaction by which the hydrogen plating out on the iron and the oxygen dissolved in the water, will unite, will in turn accelerate the corrosion. It is well-known that the union of oxygen and hydrogen takes place at ordinary temperatures much more rapidly upon a surface of platinum than on copper, on copper much more easily than on iron, and on iron more easily than on zinc. To use a modern phrase, these metals catalyze the reaction. Hence if a piece of platinum or copper be united electrically with a piece of iron, the hydrogen will be liberated on the platinum, and the iron will be free to pass into solution over its entire surface. This is shown in Figure 2. A piece of platinum wire is seen at the center of the plate and is without action. A nail is also seen corroding at the ends and setting free hydrogen upon its central portion. A second nail is connected to a piece of platinum wire; the red of the phenol phthalein is seen around the wire, while the nail is corroding very much faster than the unconnected nail. Many substances occurring in modern iron and steel, such, for example, as manganese sulphide and magnetic oxide, act in this respect just as platinum does. Their presence in the iron furnishes small points upon which the hydrogen set free can be easily liberated, and thus form the cathode pole of an exceedingly small electric couple, thus setting up a flow of electric current and forming a center of corrosion. In proportion as the iron contains many of these centers will the rate of its corrosion increase. A rough analogy may be found in the following experiment: Compress into tablets by means of an apothecary's press, (a) finely powdered zinc, (b) finely powdered copper, and (c) an intimate mixture of these two; (d) provide a small piece of brass of the same proportionate composition as (c). Place each in moderately dilute pure muriatic acid; (a) will show but slight action, very little hydrogen being evolved; (b) will not be acted upon; (c) will give off hydrogen most violently, the zinc passing into solution, (d) will show no action. While the action of acids upon metals is not strictly comparable to ordinary corrosion, it is roughly so, and the results show that if the iron be pure, its solution will be but slow, as in (a); (b) represents the impurities in the iron as various forms of sulphur, phosphorus, manganese, and carbon compounds, which in themselves may not be easily corroded; (c) shows the effect of these impurities when badly segregated, furnishing cathodic poles upon which hydrogen can be liberated, thus allowing the iron to pass into solution; while (d) indicates that if these impurities could be perfectly distributed they

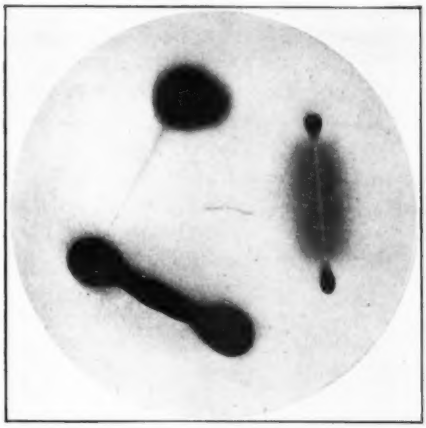


FIG. 2. CORROSION OF IRON IN CONTACT WITH PLATINUM.

would produce little influence on corrosion. Hence we should expect that the speed of corrosion of iron or steel would increase in accordance with the percentage of impurities present, and it should decrease in accordance with the care bestowed upon the iron or steel during its manufacture to prevent a segregation of these impurities. The simplest way, of course, to insure an absence of segregation is to eliminate altogether those materials not needed in the iron. It has been found that a steel made under such conditions that the total impurities are reduced to not over five hundredths of one per cent (0.05 per cent) resists corrosion to an extent equal to the iron of our forefathers. The steel companies have been slow to accept this general proposition, but it is gratifying to know that material of this purity may now be obtained on the open market.

Since iron can pass into solution only by assuming the ionic form, and having at the same time an equivalent amount of hydrogen pass from the ionic condition to the gaseous state, the speed of the reaction will depend upon the number of hydrogen ions present in the solution. If this number be enormously increased, as can be done by adding some strong acid, the reaction will be accelerated to such an extent that the hydrogen may be seen passing off the iron as a stream of bubbles. If this concentration of hydrogen ions be but slightly increased by the addition of such weak acids as the carbonic acid of the atmosphere, or the carbonic and sulphurous acids resulting from the combustion of most fuels, corrosion will again be accelerated, though to a less noticeable extent. The presence of any material (such as alum or magnesium chloride) which when subjected to pressure, or other materials which by hydrolysis, will form an acid, will also accelerate corrosion. This explains why boiler feed water should be free from magnesium chloride, for example. This salt hydrolyzes in the presence of water at temperatures above 120 degrees C. to produce the highly dissociated muriatic acid and the weak

base magnesium hydroxide, and a rapid corrosion of the boiler due to increased hydrogen-ion concentration results.

If, on the other hand, the hydrogen-ion concentration be reduced, the corrosion of the iron will also be decreased. Such a condition may be most easily realized by adding to the water a strong alkali, which, owing to the presence of a large number of hydroxyl ions, decreases thereby the number of the hydrogen ions. Iron will not rust, therefore, in a solution of soda ash, lime water, or any material (such as sodium phosphate) which when present in water will by hydrolysis decrease the number of hydrogen ions.

This fact has an important bearing upon the question which has been much discussed lately, as to whether concrete will protect iron from corrosion. Inasmuch as Portland cement when it "sets" or hardens liberates a large quantity of caustic lime, which is a strong alkali, and since good concrete is therefore saturated with this strong alkali, the answer to the question must be in the affirmative. Iron or steel will not corrode when imbedded in concrete. But caustic lime is soluble in water, and poorly made concrete is not impervious to water. Therefore, if iron be imbedded in concrete through which water at any time be allowed to percolate, this calcium hydrate will be slowly but surely dissolved and washed away, and with it will disappear the inhibiting action of the concrete, and iron imbedded therein will surely rust. To insure absolute protection of the reinforcing members of concrete construction, therefore, such concrete must be sufficiently dense and carefully made to render it practically waterproof. This is not an impossible condition, but one easy of attainment if sufficient care be taken.

By electrically connecting a piece of iron with a bronze or copper structure the latter will be protected from corrosion, because, owing to the fact that the iron passes into solution, hydrogen will be liberated upon the bronze or copper and its solution will thus be prevented. Employing the same reasoning we find that any metal with a greater tendency to dissolve than iron, for example zinc, on which the hydrogen is liberated with more difficulty than on iron, should protect the iron at the expense of this other more positive metal. This action is shown in Figure 3. A piece of zinc is seen at the center, corroding slightly from the ends, and showing the red due to the separating hydrogen ions at the center. Zinc ferricyanide is white and hence the same reagent demonstrates the separation of zinc ions, just as it does the iron ions in the plate already considered. The nail which has been connected to another piece of zinc is not corroding, but is protected by the separating hydrogen. The zinc thus connected,

however, is seen to be rapidly dissolving. This is the explanation of the well-known use of zinc in boilers for the prevention of pitting, and it is but necessary to maintain an electrical connection between the zinc and the iron to insure the complete protection of the latter, for a distance which depends upon the electrical conductivity, or purity, of the water in which the two are immersed. In perfectly pure water, zinc will protect iron but for a distance of one-half inch or so; but if salt or any other electrolyte be added thereto, the area of protection is increased to twenty inches or more.

FIG. 3. CORROSION OF IRON IN CONTACT WITH ZINC.

The fact that the presence of a metallic iron surface accelerates the corrosion of zinc has an important bearing upon the protection of such structure as barbed-wire fencing, or any structure where both iron and zinc surfaces are exposed. In making barbed-wire fencing, for example, the wire is first galvanized and then wound into fencing, the cross wires forming the barbs being cut at an angle in order to make a pointed barb. This freshly cut surface of iron is thus exposed, and so furnishes just the surface required for depolarizing the zinc surface and thus greatly increases the rapidity with which the zinc coating will corrode. As the zinc coating recedes from the iron surface, the latter rusts on account of the low conductivity of the water film on the two; hence the explanation of why deterioration of a barbed wire fence always starts at the barbs and travels from there along the strands. It also shows the necessity of protecting those places on a galvanized structure from which the zinc, for whatever cause, has been removed.

Since oxygen is necessary to insure the continuous removal of the hydrogen film, it is obvious that if no oxygen be allowed to reach the iron through the water, no corrosion can take place. This fact teaches us much regarding the corrosion of boiler shells and tubes. Pitting may be entirely avoided if the air be removed from the feed water before its introduction into the boiler. This may best be done

by the employment of an open feed-water heater, or what is better still, a feed-water heater connected to the dry vacuum pumps of the condenser. If such treatment is not possible, the air may be removed from the feed water by drawing the water through a closed box containing scrap iron; the oxygen in the water is used up in corroding the scrap iron instead of the boiler tubes. Or, the oxygen in the water may be absorbed by feeding into the boiler with the water a very small quantity of an alkaline solution of a tannin material. Such a solution of alkaline tannate will break up under the pressure and temperature of the boiler, with the formation of a pyrogallate of the alkali, and this rapidly absorbs the oxygen. Soda ash, or other alkali, is of course useful, not because of its effect upon the oxygen content, but because, as has already been explained, corrosion is inhibited by thus decreasing the hydrogen-ion concentration of the water.

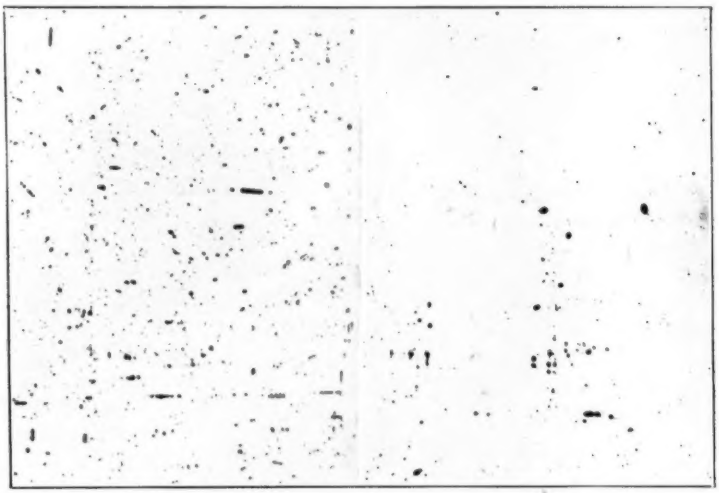


FIG. 4.
ORDINARY TIN PLATE.

FIG. 5.
HIGH-GRADE TIN PLATE.

Tin is a metal which, like copper, accelerates the corrosion of iron by aiding in the oxidation of the hydrogen set free by the reaction. If, therefore, in the manufacture of the so-called tin plate, which is sheet iron or steel covered with a layer of metallic tin, there be imperfections or pin holes in the tin coating, these channels through the tin to the iron will become centers of corrosion which rapidly destroys the plate. It is impossible to detect these imperfections by a simple inspection, and hence users of tin plate have been unable to test the quality of their raw material from this point of view. Since the iron

must pass into solution at these exposed points in the tin coating, their presence may be easily located by flowing upon the tin surface a solution of gelatine or glue in which is dissolved some potassium ferricyanide. When the jelly has stiffened the iron will pass into solution through the holes in the tin, and reacting with the ferricyanide will leave a bright blue spot in the jelly. Variations in the quality of tin plate may thus be easily detected. This is shown in Figures 4 and 5. Figure 4 is a sheet of ordinary tin plate of low quality, such as is used in canning vegetables, and is seen to be covered with pin holes. Figure 5 is a high-grade piece of dairy stock and shows but a comparatively few such imperfections.

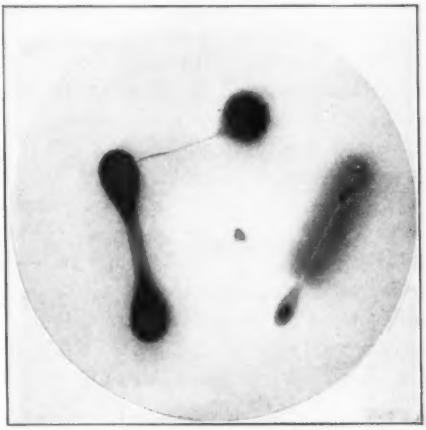


FIG. 6. CORROSION OF IRON AS AFFECTED BY MILL SCALE.

I have shown* that "mill scale" or magnetic oxide of iron is strongly electronegative to iron. Since mill scale is insoluble in water and cannot of itself enter into the reaction, its only function can be analogous to that of platinum or other insoluble conductor of this kind, viz., to furnish a surface on which the hydrogen liberated by the dissolving iron can separate and be catalytically oxidized to water again. This is also true of the black-oxide protective coatings sometimes used upon iron and steel, as, for example, that of the Bower-Barff process. Just as is the case in mill scale, these coatings are very serviceable so long as the whole coating is intact. But so soon as a portion of the metallic iron is exposed, this portion corrodes all the more rapidly on account of the presence of the surface of scale on which the oxidation of the hydrogen and consequent depolarization can go on. Figure 6 shows the influence of mill scale on the speed of corrosion of a wire nail. A piece of scale is seen at the center, while on the outside is a free nail and also one connected with another piece of scale. The accelerating effect is obvious. The inevitable result is that a pit forms at the exposed point and grows deeper and more marked in proportion as the scale is dense and closely adherent

* Journal American Chemical Society, 1907, 1259.

to the iron surface. Hence if it were possible to remove the mill scale entirely from steam-boiler tubes, for example, pitting would be largely eliminated, and the life of the tubes prolonged.

Inasmuch as both moisture and oxygen are necessary in order that corrosion may proceed, it can easily be seen that the duty of a protective paint is to exclude both of these elements. It is well-known that a linseed oil film is an excessively porous structure acting somewhat as a sponge toward moisture and freely allowing the passage of oxygen. The function of the pigments employed in paint is therefore at least threefold. First, the more obvious one of imparting a color thereto; second, the most important one of filling up the pores or interstices in the oil film, thus rendering it as little pervious to moisture and air as possible, and third, to aid the composite film in drying or oxidizing to a compact impenetrable covering. Very little work has as yet been done upon paints from this point of view, but with a clear conception of the factors involved in the corrosion of iron, an intelligent study is made possible and valuable results can be predicted with certainty. The porosity of paint films containing no linseed oil, but composed of bituminous materials which may be adapted for the purpose, may also be studied with profit with a view to increasing their moisture- and oxygen-excluding properties.

Although, as I have tried to point out, the corrosion of iron and steel is an electrolytic phenomenon occasioned by the passage of an electric current from one point on the metal to another, it must not be confounded with what is known as "electrolytic corrosion" or "electrolysis due to stray currents." While the action both chemically and physically is in each case identical, it differs in this important respect. The current flowing in the first instance is limited to the very small electromotive force produced by the difference in the solution pressure of hydrogen and iron, retarded more or less by the resistance of the external circuit. In the second case, however, the current may have any strength and is limited only by the difference of potential existing at the two poles of the generating system. The first case may be compared to the abrasion caused by a quietly moving stream through a comparatively level country where the banks are slowly worn away, being deposited somewhere else as silt. The second case is like a leak in a hydraulic main in which the water has been placed under a high pressure and is capable of producing the same action as in the first case, but greatly intensified. The first mode of corrosion is dependent upon the purity of the iron and the other conditions already noted, while the second has been artificially brought about and can to a greater or less extent be controlled.

# THE PRINCIPLE OF THE TIME TICKET.

*By L. S. Randolph.*

MODERN shop accounting requires that the following information be obtained for each part of a machine.

1.—Amount and cost of material for each piece completed.

2.—Amount and cost of material wasted for each piece completed.

3.—Labor cost of each piece completed.

4.—Labor cost of each operation on each piece completed.

5.—Labor cost of each part of an operation completed.

The first of these data is obtained from material tickets; the second usually by an approximation of or directly from the difference in weight between the finished and unfinished pieces; the third and fourth from records of the individual workmen, and the fifth usually from a study from time to time of individual cases.

The methods of obtaining the third and fourth of these it is proposed to discuss in the following article.

In this discussion the following definitions should be understood: A shop-order is an order for one or more completed machines, or work ready for delivery from the shop.

A machine is an assemblage of parts; a part is an assemblage of pieces; and a piece is a single component.

The information secured by cost accounting as summarized above may be desired for one or more of the following purposes:

1.—To obtain the detailed cost of each piece and operation, in order to make comparisons between the work of different men and the efficiency of different machines, with a view to improving both the character of the work and its efficiency.

2.—To determine accurately the prime cost of the article manufactured, with a view to obtaining lower prime costs.

3.—To study the cost of the different operations with a view to reducing these costs.

4.—To determine the rate of compensation of the men according to some predetermined plan of standard time or bonus system.

5.—To determine beyond question the responsibility for any defective work.

This information is usually obtained by one of the following methods:

By a clerk who goes the rounds of the shops and obtains the time of the men, entering it in a book and making the proper charge. These charges are then distributed to obtain a complete labor cost.

By one or other of the different forms of time tickets, made out by the workmen or by a clerk for them. These are almost invariably signed or approved by a foreman before being turned in to the time keeper, cost clerk or store keeper.

Three types of time tickets are used.

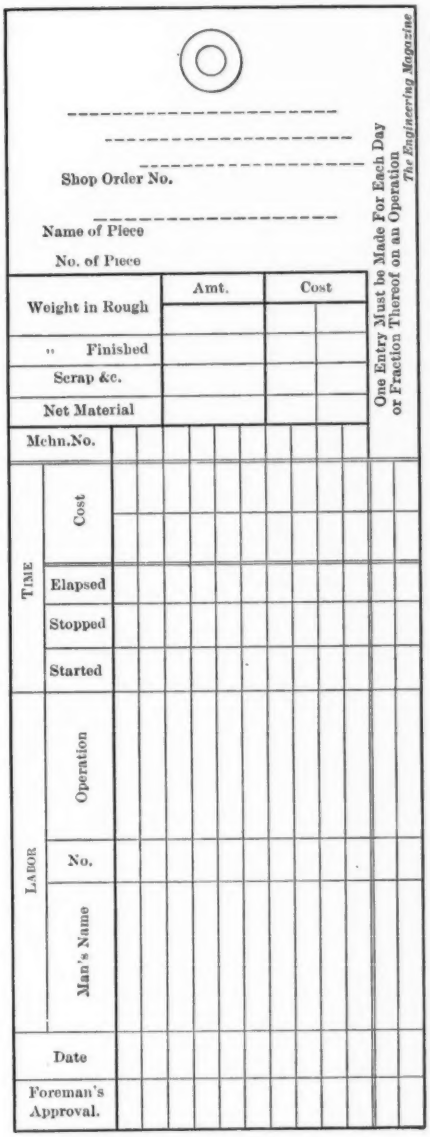
*a.* Those in which the time ticket follows the piece of work through the shop and from one shop to another, and contains the record of a number of similar pieces.

*b.* Those in which the time ticket follows the workman and contains the record of a single operation on a number of pieces of work, but the complete day's record of one man.

*c.* Those in which the time ticket contains the record of one workman and the operation he performs on a piece or many similar pieces; that is, a ticket for each workman and each piece on which he works, different operations on the same piece being entered on the same ticket when executed by the same man.

With the first type, a stout ticket is used, preferably linen-backed in the form of a tag. A typical arrangement for the form of ticket is shown on the opposite page. This should contain spaces for the following information:

The shop-order number.
Name of piece to be finished.
Number of pieces.
Weight and cost of these pieces in the rough.
Names and numbers of the workmen who finish them.
Operation or operations which each man performs.
Numbers of machine used for the operations.
Time at starting of each operation.
Time at completion of each operation.
Elapsed time for each operation.
Date of operation.
A space for the cost of each operation and for the total labor cost.
Finished weight of the pieces.
Material lost during process of finishing. Scrap value of same.




TIME TICKET. TYPE I.

It will be seen that when these cards are returned to the storeroom, they contain all of the data to determine:—

First, the prime labor cost.

Second, the prime material cost.

Third, the material to be credited at scrap prices.

Fourth, the information for charging a machine rate, if that form of distributing uncharged expenses is used.

From the above an accurate statement of prime cost can be obtained; but in order to obtain the workmen's time or to check the time book, time must be taken from the time tickets and entered upon or checked against another card or book, and at the end of the month time must be taken from tickets still on the floor, in order to make the month's record complete.

The advantages of this form of ticket are as follows:—

*a.* Detailed cost of pieces and operation is obtained at once upon completion of work and in a form readily filed for reference.

*b.* Complete statement

of prime cost of piece is secured as soon as work is received in store room.

*c.* Prompt and accurate record can be made of the day's output of completed work.

*d.* Work in shops can be promptly located and kept well together.

Disadvantages of this form of ticket are:—

*a.* Tickets are a long time on their way through the shop; hence, prompt supervision of the workmen's time can not be obtained by the office—frequently not until two to three weeks have elapsed.

*b.* There is danger of ticket being lost or mislaid.

*c.* Tickets are nearly always soiled or mutilated.

*d.* Time of men must be taken from the tickets, with consequent likelihood of error, and with much difficulty.

*e.* Information obtained by the foreman from these tickets is not as full as it might be, as they are not in his hands long enough for careful study.

The second type of ticket, shown on the opposite page, should contain spaces for the following information:—

Name of the workman with his shop number.

Date.

Number and type of the machine operated.

Shop-order numbers of the pieces worked on.

Names of the pieces.

Time at starting the work.

Time at completion of work.

Elapsed time.

Rate of the man.

Machine rate if used.

Foreman's approval.

The advantages of this type of ticket are the following:—

*a.* Workman's time is at once obtained.

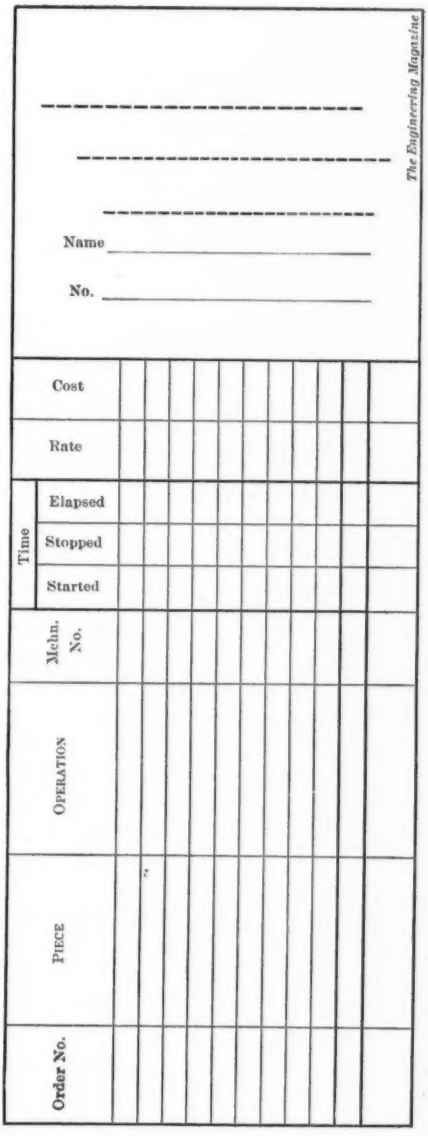
*b.* Close supervision of the workmen under him, can be obtained by the foreman, as the detailed record of the day's work is in his hands at the close of the day's work.

*c.* Tickets are kept cleaner and less liable to mutilation.

Disadvantages of this form of ticket are:—

*a.* No material records can appear on this ticket, but a separate ticket system must be kept for material accounts.

*b.* Prime labor costs must be taken from a number of these tickets with nothing to check against; that is, the cost of the labor on a certain piece must be obtained by adding up the cost of the several




TIME TICKET. TYPE 2.

operations on that piece, which can be obtained only from separate time tickets.

The third form of time ticket (exemplified on page 214) should contain spaces for the following information:—

Date.

Name of workman with his shop number.

Shop-order number.

Day or piece rate.

Name of piece.

Operation.

Elapsed time of operation.

Cost of operation.

Foreman's approval.

With this form of ticket each workman turns in to the foreman for approval one to half-a-dozen tickets, which after being examined and approved by the foreman are turned in to the time keeper or cost clerk; from these the information is obtained. The tickets are usually sorted according to workman's names, and the time as turned in by the gatekeeper is checked by comparison with them. They are then sorted according to shop-order numbers, and the labor cost of each shop-order number for the day is obtained. They are then filed according to

shop-order numbers, and when the job is completed the tickets can be sorted out according to pieces and operations and the detailed costs thus obtained.

TIME TICKET—NAME OF CO.

Date.....

Name..... Rate.....

| Order No. | PIECE | WORK | No. of Hours | No. of Pieces |
|---|---|---|---|---|
| | | | | |

Correct..... Foreman

*The Engineering Magazine*

TIME TICKET. TYPE 3.

This form of ticket has the following advantages:—

*a.* The tickets can be readily sorted out according to workmen's name, pieces worked on, or operation, and the extensions taken from the tickets without entering the individual items in a book or on a pad.

*b.* All tickets of one shop-order number can be filed together with the shop-order card, thus giving a complete, detailed record of the prime cost of that shop-order number. To be studied when needed.

*c.* They are suitable for all classes of work, large or small; few or many operations, and for repair work, construction or erection.

Disadvantages are as follows:

a. Large number of tickets makes the danger of lost or mislaid tickets much greater.

*b.* Cost of piece or operation, and time of man must be footed up from the tickets, and entered on another record. In both of the other types of tickets one or other of these items can be footed up and entered on the ticket and checked direct.

*c.* No material records are possible on these tickets.

These types of tickets or modifications of them are suitable for different kinds of work:

For manufacture of definite kinds of machines with little or no repair work and few variations, the first type of ticket is unquestionably the best, as complete records of detail cost are readily and promptly accessible for comparison. When upon making such a comparison an excessive cost is found for any operation or piece, the tickets at once show the man and the machine upon which the responsibility falls for the unfavorable comparison. The labor of obtaining the time of the men for making or checking a pay roll, is but slightly greater than with the other types of tickets.

Where much repair work is done or where there is a great variation in the amount of work done the first type of ticket loses much if not all of its value. It should be said, however, that much depends on the method of management. Economy in detailed operation of machinery must be produced in two ways:—

By careful study of machine cutting, speeds, and feeds, and the facility given by different kinds of auxiliary machinery such as chucks, jigs, etc., and in setting the piece in the machine.

By watching the workman and observing how far he departs from the standard time of the given machine and operation.

Where day work is used, the only method of reducing time on work is to jack up the workman whenever he falls short. The first system of tickets does not admit of doing this with sufficient promptness, unless the duty devolves on the foreman who makes the point with the workman at the time he approves the operation on the ticket. Supervision of the foreman can be had with sufficient promptness by observing, when these tickets come in, whether the time which should have sufficed for the work has been exceeded.

With day work, the second and third systems of tickets can be used satisfactorily, as the superintendent, if he so desires, can have these tickets on his desk for examination the morning after the work is done so that any dereliction can be promptly looked after. When men are paid according to some standard time, as Taylor's, or some similar method, the first system can not be used with satisfaction, as it would require that all tickets on the floor or attached to uncompleted work should be examined before the pay-rolls can be made out. With weekly pay-rolls this would be too much of an undertaking. It is true that separate tickets for each shop can be used, and where there are many operations on one piece this may be necessary in order to prevent the tickets being too large and cumbersome; but as a rule all operations on a piece can be entered on one ticket.

Again, the first form of ticket does not lend itself well to large

pieces of work, such as the erection of large machines, where a number of entries must be made on one ticket. In fact, this ticket suits best for what might be called a manufacturer's shop, where machines are built in lots, and where when a machine is ordered the tickets are made out and attached to the material as sent from the store room.

The second and third types of tickets are particularly well suited to a careful study of the work of an individual man as well as the operations which he performs, as they come promptly to the superintendent; but ticket number two does not admit of the cost of the operations on the different pieces being readily determined. These items must be picked off, one by one, and entered on a second card or in a book; hence the increased cost of the system and the greater liability of error. The chances of loss or mutilation of tickets are principally with the shop men, who are unaccustomed to handling papers.

In the third type, the tickets after having been approved by the foreman are sent to the time keeper, by whom they are sorted out according to the names of the men and the time is taken from them. Afterward they are sent to the cost clerk and by him sorted out by shop-order number, by pieces and operation. Here we have the additional work of sorting and entering on the cost clerk's records with one redeeming feature viz., that all labor tickets, material tickets, order card, and finished weight tickets, can be filed in one envelope, which will then contain the complete records of every operation, and by making the entries on the envelope we have all these original records together; and though not in so compact a form as the first type, they are much more complete and the entries on the envelope may be as compact as is desired.

As regards the cost of these different methods of obtaining time: the second and third types will take more time of the clerical force than the first, but the time of the workman when he makes out the ticket himself will be about the same for each type of ticket.

# THE RENAISSANCE OF THE ABSORPTION MACHINE.

*By Jos. H. Hart.*

**The rapidly widening field of usefulness opening to mechanical refrigeration was suggested by Dr. Hart's article in our February issue. A very definite measure of the valuable economic results in one direction—that of iron and steel making—is given by Dr. Waterhouse elsewhere in this issue. These new opportunities, most important though but a short time ago quite unforeseen, give new interest to the subject and to its further study on the side of mechanical design and construction as here pursued.—THE EDITORS.**

THE absorption machine until recent years has been out of the general line of engineering experience. Its history is unique. Antedating the compression machine in time of development, it was practically rendered obsolete by the latter and it has only been within the last decade that it has again forged to the front. Today it is a strong competitor of the compression machine in nearly every industrial application of mechanical refrigeration.

Mechanical refrigeration is no longer an isolated fact in engineering. With a range of applicability extending from the cooling of a photographic dark room to the removal of moisture from the blast in iron-furnace operation, its further efficient utilization as an energy reservoir in power-plant practice has brought it to the attention of the ordinary engineer in a manner that demands recognition. The possibilities of pipe-line refrigeration and the extended consumption of power in small units for refrigerating purposes serve merely to increase its importance. Ammonia is now recognized as the most satisfactory vehicle for the conveyance of the heat in the production of refrigeration and occupies a position analogous to water in power production. Of the two types of ammonia machines now in use, the compression machine has attained a high state of mechanical efficiency, whereas the modern development of the absorption machine has scarcely commenced. Even thus handicapped, the situation exists today that an absorption machine of the same refrigerating capacity can be operated from the exhaust steam alone of a corresponding compression plant, and some authorities even put its capacity at double this figure under the same circumstances. This sort of thing betokens an approaching revolution in refrigerating practice, and the reasons for this state of affairs and the probable quality and extent

of the approaching changes are of the greatest interest not only to the refrigerating specialist, but to the general practitioner in engineering as well.

Probably the greatest obstacle in the rapid progress of the absorption machine to its proper position in the refrigerating world today is the wholesale lack of knowledge shown by the average engineer not only in regard to the capabilities and best conditions for operation of the absorption plant, but even of the names and purposes and operations of the various units composing the absorption plant itself. In addition, only a small number of refrigerating engineers have made a specialty of this machine, and although this number is rapidly increasing, the remainder (often mindful of earlier experiences with this type) are frankly sceptical in regard to its possibilities. Further, it is almost impossible to find an operating engineer who can satisfactorily maintain a plant in efficient operation for any considerable length of time. This is sometimes due to lack of knowledge or experience, but more often to an experience obtained with old-style absorption machines, many of which still operate and maintain a dreary and inefficient existence. The situation can be summed up briefly by the statement that the modern absorption machine is struggling against a powerful competitor and against all the evil influences left by its inefficient prototype. All these conditions are merely temporary, however, and the absorption machine will soon attain its rightful position in the refrigerating world, for the movement attains impetus as it progresses.

The reasons underlying the curious historical behavior of the absorption machine are not hard to find nor difficult to understand. Developed originally at a time of universally low efficiency in the entire mechanical world, it was generally constructed in a haphazard manner, which was practically inevitable because of almost complete lack of knowledge in regard to the physical properties of ammonia gas in connection with water or aqua ammonia. Isolated in the character of its operation from other mechanical developments, it did not at once respond to the movement for increased efficiency, and the improved and efficient compressor on its advent into refrigeration found an easy victim. The apparent ease and simplicity of its operation, however, has made it since then a favorite subject for much misdirected and expensive engineering experimentation, which has not tended to increase its reputation. The compression machine has been slowly and steadily developed to its maximum efficiency under existing conditions. Further improvements are possible in minor details only, and the problems of the compression machine have become

the problems of power and its more efficient utilization. Engineering attention was then turned to the possibilities of the absorption machine for further advance and its progress has become rapid and certain.

Now in order to understand more fully these possibilities and to obtain a clearer comprehension of the problems involved in this development and the special reasons for the former low efficiency of this type, it will be necessary to make a brief *résumé* of the operation of the absorption machine from both a theoretical and practical viewpoint. The action of the absorption machine in the production of refrigeration is identical with that of the compression plant. In both cases, the ammonia gas is compressed, it is carried under pressure into the condenser, where it is cooled by cold water and condensed, and then the liquid ammonia thus produced is allowed to boil away in the shell cooler or cooling coils under a suitable pressure and it there absorbs its latent heat of evaporation from surrounding bodies, thus producing the refrigeration. In the compression system, the compressor serves two purposes. The apparatus compresses the gas to a sufficient pressure for condensation, and its suction side carries off the ammonia gas from the cooling coils, thus maintaining a definite pressure there and hence a definite boiling point for the liquid ammonia. In the absorption system, these two duties of the compressor are performed by two machines, known respectively as the generator and absorber, which utilize the peculiar absorptive power of water for ammonia at ordinary temperature and the loss of this property by water with rise in temperature. In the generator, strong aqua ammonia is heated by steam pipes, which are connected to the boiler, and the ammonia gas is evolved and compressed in precisely the same manner that pressure is produced in a steam boiler. The process is made continuous by allowing the strong aqua ammonia to enter at the top, becoming heated and losing its charge as it descends, and emerging at the bottom as hot, weak aqua ammonia. It is then cooled and admitted to the absorber, when it rapidly absorbs the ammonia gas coming from the cooler and performs the suction duty of the compressor. It gets rapidly hot here due to the heat of absorption of ammonia gas in water and it must be kept cool in order to retain its absorptive power. This is accomplished by cold water in pipes traversing the absorber. The aqua ammonia leaves the absorber as cold, strong aqua ammonia and is heated partially before it again enters the generator to repeat the cycle. This completes the theoretically necessary units in an absorption plant, with the exception of a slow-speed pump for forcing the strong aqua ammonia back into

the generator against the pressure of the hot ammonia gas. Operated thus simply the process is extremely inefficient. The heat waste is enormous, since the aqua ammonia is heated continuously at one point in its cycle and cooled constantly at another. The quantity of water used for cooling purposes is extremely large, and to cap the climax there may be very little refrigeration produced, and in extreme cases, none. This latter condition is due to the occurrence in the generator of a phenomenon equivalent to priming in a steam boiler and to the additional production of steam or water vapor in the generator along with the ammonia gas. This water vapor enters the condenser and is changed into water when the ammonia gas is condensed. It then and there absorbs the ammonia, so that if there is enough water condensed, no liquid ammonia is left and only strong aqua ammonia enters the cooling coils and it does not of course evaporate and produce refrigeration.

As a result of this condition of affairs two extra units were installed in the standard absorption plant. They are known respectively as the exchanger and dehydrator and their names denote their purpose. The exchanger is a device whereby the hot weak liquor as it leaves the generator is used to heat the cold strong liquor as it enters at the top of the generator, and the cold strong liquor as it leaves the absorber in turn cools off the weak hot liquor as it enters the absorber. The economy of this device is an economy of heat and of condensing water as well. The dehydrator is a device which partially cools the ammonia gas and which condenses the water vapor and returns it to the generator and allows almost dry ammonia gas to enter the condenser.

These five units, therefore—the generator, the absorber, the exchanger, the dehydrator and the ammonia pump—perform the same duty in the absorption system as the compressor in a compression plant and the remaining mechanism in both cases is almost identical. With the exception of the pump, however, these units consist merely of assemblages of pipes and castings and are comparatively simple in construction and require very little attention. The efficiency of such a plant has been found within wide limits to be a function of the design of the machinery and the skill of the operating engineer almost exclusively. A generator of modern design eliminates priming almost entirely and allows the utilization of very low-pressure steam, often the exhaust from other plants, and makes the production of water vapor a minimum, thus diminishing the work required of the dehydrator. A properly designed dehydrator under these circumstances

will produce an ammonia gas 99.5 per cent pure. As an illustration of the care and skill required in the operation of such a plant, it can be stated that a difference of a few degrees only in the temperature of the ammonia gas as it leaves the dehydrator means a large cut in the refrigerating capacity of the plant. A properly designed water system, utilizing the greatest possible heat capacity of the water for cooling, by arranging the various units in suitable series, has been able to cut the water consumption enormously and to make it on a par with the compression system in regard to this item. Even with this showing, the designs are in every case purely tentative. No standard results have been attained, and none can be attained without a more complete knowledge of the physical constants for aqua ammonia under various conditions of pressure and temperature and in contact with ammonia gas. These are slowly forthcoming, but there is a large mass of data required and it will be some time before this is complete. Even under these conditions, it is now recognized that the absorption machine has returned to stay and its relations to the compression machine are well defined.

For small refrigerating units the compression system is much superior, not on account of increased efficiency in regard to coal consumption, but on account of its much smaller first cost and on account of the labor item, since a small compressor can almost run itself; and indeed there are a number of small automatic machines of the latter type at present on the market. But as the refrigerating units are increased, the comparative cost of the absorption machine rapidly decreases until at 20-tons capacity it is quite on a par with the compression plant when all the determining factors are considered. Above this capacity its superiority is more or less pronounced, depending on the nature of the refrigeration required, and it seems destined to increase this lead very much. At present, as has been said, the issue has been much obscured, and many of its more remote advantages are still subjects of considerable discussion. The nature of the refrigeration required is a strong factor in determining the relative efficiency of the two machines. For mild refrigeration the compression machine holds its own fairly well, but for extreme refrigeration the absorption machine possesses a decided advantage which follows as a result from the fundamental principles involved in their operation. Compressors are designed to work on a condensing pressure of 185 pounds and a suction pressure of 15 pounds, and under these conditions are rated per ton refrigerating capacity in 24 hours' operation as equivalent in refrigeration to melting ice per

ton in 24 hours. If the suction pressure is diminished the capacity of the compressor for ammonia gas is diminished, provided the speed remains constant, and the refrigerating capacity of the machine falls off rapidly, since this depends simply on the amount of ammonia gas liquified in the condenser. Now the temperature of boiling liquid ammonia depends directly on the vapor pressure above it, and this must be diminished very much below normal in order that the ammonia shall cool off to the temperature required in extreme refrigeration. Under exceptional circumstances the rated capacity of a compression plant may be cut in half if an extremely low temperature is required in the cooler. The absorption machine, on the other hand, works better, if anything, for the lower temperature. The weak cool aqua ammonia possesses such an avidity for the ammonia gas that its pressure on the suction side is never allowed to increase very much above the atmosphere even for rather warm liquor, and a slight fall in the temperature of the liquor will carry the pressure considerably below that of the atmosphere and produce a partial vacuum. This latter feature is often objectionable in practice, since the air in solution in the aqua ammonia is then liberated and often the weak liquor syphons back from the absborber into the cooler where the heat of absorption by the water counterbalances the refrigerating effect produced by evaporation. This, however, is merely another factor which makes the operation of the absorption machine a difficult matter for an operating engineer not thoroughly familiar with his business, and is not an insurmountable difficulty or one that militates against the plant to any great extent.

Not only are the two different types especially adapted for their own particular field, since for mild refrigeration the rated capacity of the compressor is often much increased as well and the compression itself is carried on more efficiently on account of the high initial pressure, but in many other respects the two machines fit harmoniously together in the division of the field of labor. A compression machine utilizes high-pressure steam in running the compressor and the engine unit is often compound with superheated steam. An absorption machine utilizes merely the heat in the steam, and high-pressure superheated steam is not much of an advantage in this type. The absorption machine utilizes more heat in its operation than the compressor does, but it utilizes almost all the heat that comes from the boiler in some way or other, whereas the engine running the compressor wastes an enormous amount of heat in its exhaust, and in a comparison of the total heat taken from the boiler in the two cases

the absorption machine has a decided advantage. Again, in the absorption machine, the latent heat of steam is the important factor, as the steam heats up the aqua ammonia by its own condensation. The latent heat of steam is a function of the pressure and temperature at which the change of state occurs, and if the steam is produced at a sufficiently high temperature and pressure its latent heat of evaporation or condensation becomes zero. Thus the total heat in a pound of high-pressure superheated steam is only slightly greater than that in a pound of steam produced at atmospheric pressure, although its available heat for power purposes is much greater. Thus we come to a decided disadvantage of the absorption machine. It cannot utilize superheated or high-pressure steam with the corresponding increase in efficiency that is possible in the operation of a compression plant with this steam. Thus its development has been largely confined to the utilization of exhaust steam from compression plants, or from any other source whatsoever. Generators are now built to operate satisfactorily on a steam pressure of 1 pound or less, although in actual practice the pressure may rise to 3 or 4 pounds and this pressure is not an objectionable feature except in compound condensing engines. Its relative value in comparison to this latter feature in power-plant development has not, as yet, been satisfactorily solved, but in refrigeration alone its position is assured. Thus if we assume that a compression plant of 100-tons refrigerating capacity is able commercially to produce 8 tons of ice to 1 ton of coal consumed, then a modern low-pressure absorption system of the same capacity can produce 11 tons of ice to the ton of coal consumed, whereas a 50-ton compression plant run in conjunction with a 50-ton absorption plant, the exhaust steam from the former being used to operate the latter, is able to produce commercially 14 tons of ice to 1 ton of coal consumed. Of course, these figures are relative merely, since a compression machine often operates in practice on a 5-to-1 basis, and in a series of tests under efficient conditions may rise as high as 11-to-1 proportion, but the relative values are closely approximate. Offset against these figures are the relative costs of installation and maintenance; but these differences are not as great as is supposed, since compression plants of this size use compound condensing engines of high efficiency and high first cost.

This brings us now to the subject of the absorption machine and its relation as a refrigerant to certain external conditions, notably its utilization of excess power in the operation of a power plant. Of course, in the operation of power plants for the trolley and lighting

service, the load is variable and is often greatly in excess of the average load throughout the day. At one time this excess load was cared for by storage batteries, but their cost of maintenance was such that it was found cheaper to install a plant capable of caring for the peak of the load continuously. There has been a more or less successful attempt to create a market for the intermittent excess power that results under these conditions, and the utilization of electricity as the motive power for a large number of small refrigerating machines of the compression type has aided the development of the latter machine. The non-continuous character of this available power renders it objectionable for much work, but has no effect in refrigeration if a cold-brine storage tank is used to tide over the inactive intervals. Thus this development is especially adapted for this excess power, and many power plants now have their own compressor to utilize their excess power and convert it into refrigeration, which may in turn be stored in a large brine tank and used with greater or less regularity in a cold-storage plant or ice factory. But now the absorption machine can utilize the exhaust steam in still more refrigeration, and we are led to the possibility of the elimination of compound condensing engines and the more efficient utilization of the total energy involved, when all the factors of first cost and maintenance and operation are considered. Of course, this seems a mere possibility at present, but every little improvement in the absorption machine strengthens its position and it is merely at the beginning of its development. It will probably never entirely supersede the compression machine, with its compactness and ease of operation in small units, but it will materially modify its utilization in every one of its practical applications.

Now the only things remaining to consider are the nature and character of the improvements in the absorption machine which are impending. Betterments in efficiency are almost of daily occurrence and the limit is not in sight. Radical changes involving the elimination of the water and the water vapor are not impossible. Other substances have been discovered with an even greater affinity for ammonia than water, and only await commercial development. The steam ammonia pump will probably be replaced by some special form of the injector and the use of steam itself may be eliminated. The only great advance possible in the compression system, on the other hand, is its advent into the rotatory field, so that the absorption machine is destined to hold a position of greater and greater importance with the lapse of time.

# METHODS OF THE SANTA FE. EFFICIENCY IN THE MANUFACTURE OF TRANSPORTATION.

*By Charles Buxton Going.*

## III. MANUFACTURING POLICIES FOR THE ECONOMICAL MAINTENANCE OF MOTIVE POWER.

The series of which this article is the third began in our March issue. Preceding parts have summarized the chief problems of the Santa Fe and their solution, and the stores-keeping system in its relations to the mechanical department and the manufacturing organization in the shop. The article in this issue defines the general outline of the "efficiency methods," and a following installment will trace the extension of the bonus plans. A concluding paper in July will cover the apprenticeship system and other characteristic relations with employees.—THE EDITORS.

THE demonstration of Santa Fe methods which has been most noticed is the "betterment work," carried out extensively in the mechanical department, particularly in the work of repairing locomotives and freight cars, handling miscellaneous supplies on engines, and in other shop and road operations. The principal elements of this work have been, first, the centralization of manufacture at shops best fitted to do the work for the entire system, with consequent withdrawal of work and to some extent of machines from outside points; second, standardization of parts, of tools, and of operations; third, supervision of tools and methods, the origination and application of special tools, jigs, and devices to facilitate labor and increase output, and the betterment of machines, motors, shafting, pulleys, belting, etc., so as to remove causes of inefficiency and delay; fourth, the reduction of labor costs and the increase of efficiency in all shops, main and secondary, by the application of a system of individual reward for effort through payment of a bonus based upon efficiency.

No wisdom expressed in the advanced manufacturing systems of the day is greater than the wisdom of recognizing that the efficiency of the whole organization is the efficiency of the individual workman, and that the efficiency of the workman is secured and stimulated by providing an adequate reward proportioned to his production. In devising and applying methods which make it manifestly to the men's interest to produce with high efficiency, the Santa Fe is abreast with

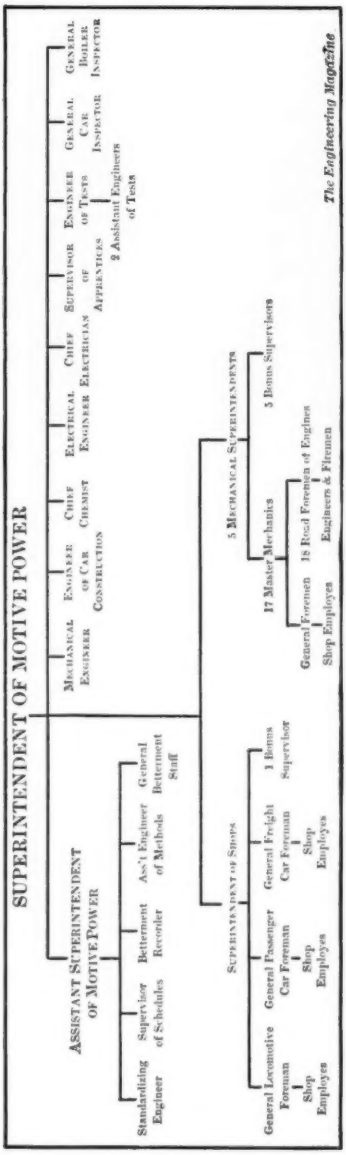



DIAGRAM SHOWING ORGANIZATION OF THE SANTA FE MECHANICAL DEPARTMENT.

the foremost industrial ideals of the times, and far in advance of most business concerns. And this is peculiarly noteworthy because the course is not taken under spur of the direct competition that drives manufacturers willingly or unwillingly to progress. It is inspired and guided by a vivid realization and an energizing acceptance of the great economic commandment "Thou shalt not waste." The results are significant in the figures of net earnings, but they have a far wider meaning yet in national and universal economy. They point to possibilities in the conservation of finances which would lead directly to enormous expansion of financial support for railway enterprises.

The purposes in view in all this work have been not only reduction of maintenance cost, but the restoration of harmonious and cordial relations based on mutual respect and confidence between employer and employee; the improvement of the condition of the worker, with simultaneous attachment to the company of more reliable and trustworthy employees; the automatic increase (without fixed limit) of the pay of good men, according to results dependent wholly on the men and not on their immediate

JAPANESE HANDY MACHINIST OPERATING WHEEL LATHE, NEEDLES, CALIFORNIA.
One man at $3.50 formerly finished one pair per day and put in another ready for turning. The Jap does two pairs of tank wheels and a pair of trailers, at $1.80 per day.

superiors; the increase of shop capacity without addition of new equipment; the increase of the reliability of work turned out or of the efficiency of work done—and the accomplishment of all these things not only without cost to the railroad company, but with marked reduction in its expenses.

The first three of the elements above referred to—that is, centralization, standardization, and improvement of shop operations and methods—were set forth in some detail in Mr. Jacobs' articles which were published in the issues of this Magazine from July, 1906, to January, 1907. They are effectively shown, further, in the many illustrations collateral with the text of this article. We may therefore concentrate our attention especially upon the operation of the efficiency system in connection with this work—that is, with the application of standard schedules and bonus payments to the maintenance and repair of locomotives and cars. This is the main item of expenditure under the jurisdiction of the motive-power department, the total outlay being divided between labor and material in about the proportion of two-thirds and one-third respectively. In the aggregate it amounts to some $10,000,000 annually, and it therefore affords an opportunity not only financially important in itself, but conspicuously prominent as an example for emulation in other departments of the road. The comparative figures of performance and expenses

INTERIOR OF ROUNDHOUSE, RATON, N. M., SHOWING ELECTRIC CRANE ON CIRCULAR TRACK.
For handling domes, front ends, superheaters, cylinders, etc.

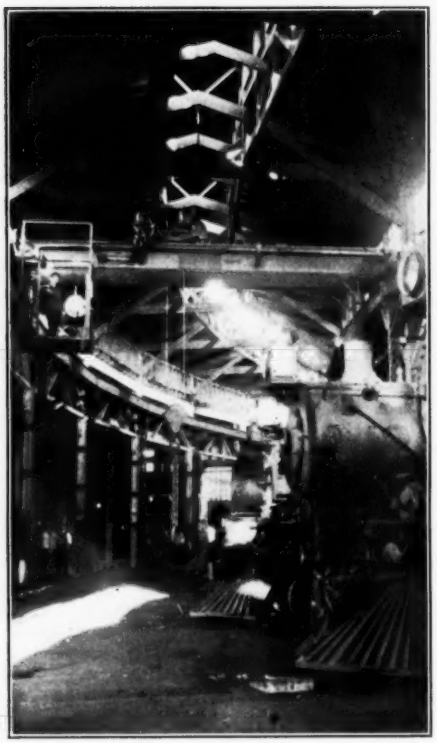
of the mechanical department show that as between 1907 and 1908 the cost of all locomotive repairs was reduced from $5,521,218 to $4,590,827; the cost per assigned engine fell from $3,246 to $2,585, and the cost per locomotive mile from $0.108 to $0.101. The decrease in total cost for the mechanical department in 1908, as compared with 1907, was $3,337,292, though this cost included an increase of $202,154 in bonus payments, and the power was kept in better condition as shown by an average of 2,254 miles more per engine failure*—an improvement of 54 per cent.

The Santa Fe road follows the system of assigning engines to a regular and permanent crew, instead of pooling them, under the conviction that this secures a very much higher interest in and higher care for the motive power. The engineer is individually interested in his machine, feels an individual moral responsibility for its condition and its repairs, an individual anxiety that it shall make its assigned mileage between general repairs, and an individual pride if it exceeds that mileage. Repairs considered necessary are commonly reported first by the locomotive engineer, or specially by the road foreman of engines. In the latter case the repairs are usually made without further inquiry. In the former case they pass under the decision of the general foreman or the roundhouse foreman. In addition, an inspector goes over the engine every time it comes into the roundhouse;† roundhouse foremen are also required to keep in touch with engineers as to the condition of their engines, and hostlers and wipers are encouraged to report any defects they may find which have escaped the eye of others. And after all this, several master mechanics remarked to me, independently: "I make close inspection of my power myself."

If repairs requested by an engineer are not made he is directed by recent general orders to write a statement to the mechanical superintendent, sending copies of the same letter to the master mechanic of his division. The round house foreman submits weekly reports of all repairs asked for but not made, with a statement of reasons in each case. These reports go to the master mechanic, the mechanical superintendent, and the superintendent of motive power. The effectiveness of this system must be judged by results of two kinds—the condition of the power, and the cost. As to the former, engine failures have been brought down from 11,880 in 1907 to only 6,952 in

* An "engine failure" on the Santa Fe is any trouble with a locomotive causing a delay to the train of five minutes or more arriving at or leaving terminals, or causing a delay of five minutes to another train, and every engine failure means an investigation.

† The employment of special inspectors was not in use at all points at the time when these studies were made.



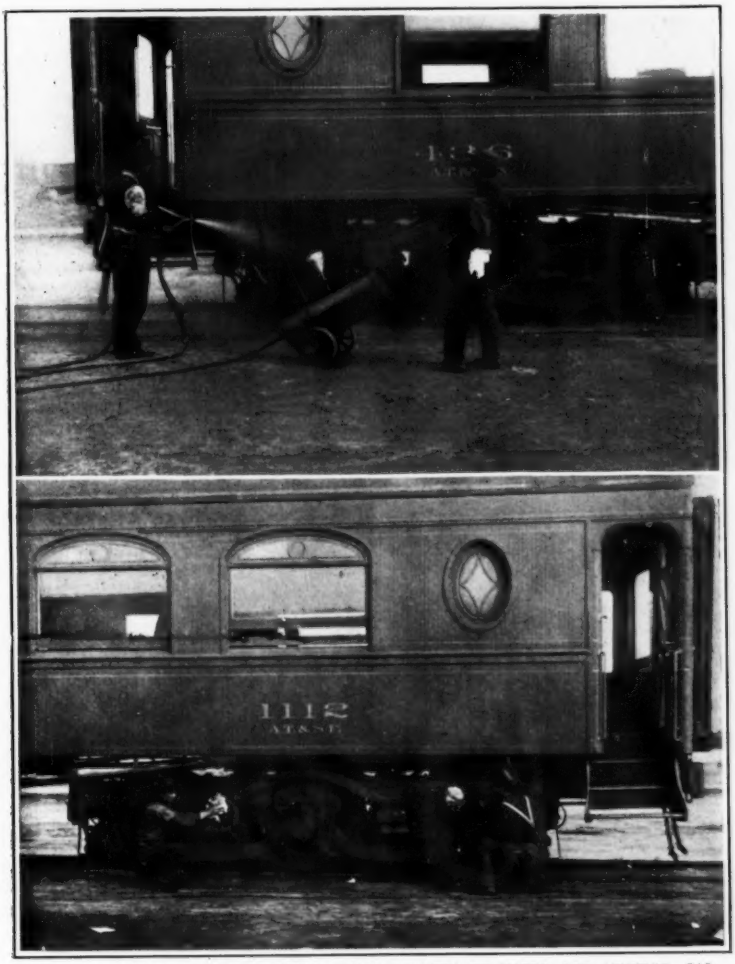
INTERIOR SANTA FE ROUNDHOUSE, NEEDLES, CAL.
Showing 8-ton crane on circular track.

1908, of which but one-third were in passenger service. This is but one failure per 6,400 miles. It is interesting to see the play of expression on the face of a Santa Fe master mechanic as he inquires each morning, "What is on the 87 report"* for his division—the sunshine of his looks if his division has a clear record, or the sudden cloud if his engine failures loom up large. The natural tendency under such conditions would be toward over-anxiety and over-expenditure for repairs. But here the bonus system interposes a countercheck. In fact, the power out of service for repairs at the end of 1907 was but 13 per cent, and for many months of 1908 it averaged but 14.9 per cent,† including in the total even repairs detaining engines but twenty-four hours. The figure for the road used to be 25 per cent. The corresponding labor costs are best shown by the figures obtained from the President's annual report for the system. The table below shows the progress of economy in the labor account for engine repairs over a five-year period.

| Fiscal Year. | Labor Cost. | Locomotives Owned. | Cost per Engine. |
|---|---|---|---|
| 1902-3 | $2,362,040 | 1,309 | $1,804 |
| 1903-4 | 3,000,122 | 1,433 | 2,094 |
| 1904-5 | 3,336,963 | 1,454 | 2,309 |
| 1905-6 | 2,739,195 | 1,633 | 1,677 |
| 1906-7 | 2,800,250 | 1,791 | 1,564 |
| 1907-8 | 2,763,825 | 1,851 | 1,493 |

* The chief dispatcher's report of delays to trains.

† A corresponding gain has been made in the handling of bad-order cars. The cost per car repaired fell from $5.07 in 1907 to $4.22 in 1908, equal to a reduction from $0.2037 to $0.1861 per 1,000 gross freight ton miles.




NEW AND OLD METHODS OF OILING TRUCKS, SANTA FE YARDS, LOS ANGELES, CAL. The old method, shown below, required one man one hour per car; the new method using compressed-air spray, illustrated above, takes two men about 5 minutes per car.

As already noted repairs are classed as roundhouse or running, light, or heavy repairs as the case may be. As soon as repairs become extensive enough to be classed as "light," they are effected under a time schedule, fixing the number of days the engine may be held in the shop. Full time schedules are worked out for light repairs, heavy repairs, and general repairs, the "heavy repair" schedule being given herewith as an example. (See pages 248 and 249.)

TIME SCHEDULE OF HEAVY REPAIRS.

FIRST DAY.

Engine in shop.
Wheels out from under engine.
Rods removed.
Driving boxes removed.
Pistons and guides removed.
Ash pan down and delivered to department.

SECOND DAY.

All material delivered.
Engine stripped.
Valve bushing out.
All parts delivered to their respective departments.

THIRD DAY.

Valve bushing machined.
New cylinders machined.
Flues out.
All machinery cleaned.
Smoke arch removed.
Stay bolts inspected.

FOURTH DAY.

Frames welded, or new, or straightened.
Valve rods, yokes and stems forged.
Throttle rigging forged.
Motion work forged.
Grate rigging forged.
Cylinders patched.

FIFTH DAY.

Valve bushings in.
Frames and decks machined.
Eccentrics and straps machined.
Steam chest work machined.
Cylinder bushings machined.
Valve rods, yokes and stems machined.
Piston rods forged.
Cylinders bored.
Guides, guide blocks and guide yokes forged.

SIXTH DAY.

Brake rigging forged.
Springs and rigging forged.
Rods forged.
Driving boxes machined.
Tumbling shaft and boxes machined.
Steam and dry pipes machined.
Guide yoke machined.
Throttle valve and rigging machined.
Brake cylinder machined.
New cylinders up.
Cylinder bushings in.

SEVENTH DAY.

Cab work machined.
Cylinder heads machined.
Guide yoke up.
Frames and decks on and bolted.

EIGHTH DAY.

Rocker boxes machined.
Crossheads machined.
Spring and brake rigging machined.
Guides and blocks machined.
Piston rods and heads machined.
Engine truck work forged.
Binders forged.
Brake cylinders up.
Back cylinder heads up.
Wheels ready.
Machine work for link gang.
Machine work for guide and piston gangs completed.
All forged work done.
Guides and crossheads ready.
Rocker boxes empty.
Tumbling shaft ready.
Reverse lever and reach rod ready.
Wheels ready.

NINTH DAY.

Grate rigging machined.
Binders machined.
Rocker boxes up.
Tumbling shaft up.
Reach road and reverse lever up.
Guides up.
Flue sheets and stay bolts in.
Flues in.
Machine work for rod gang completed.
Running board brackets up and lined.
Cab on.
Running boards on engine.

TENTH DAY.

Fitting for test on and up.
Throttle valve up.
Throttle rigging up.
Dry pipe in engine.
Boiler tested.
Boiler work completed.
Engine truck work machined.
Shoes and wedges laid off.
Miscellaneous machine work completed.
Steam chest work ready.
Drill press work done.
Truck equalizer fulcrum up.
Center casting up.

ELEVENTH DAY.

Springs up.
Eccentrics and straps on axle.
Engine truck ready.
Steam chest work up.
Lagging on.
Shoes and wedges planed.
Floor work before wheeling completed.
Driving box work before wheeling completed.
Motion work ready.

TIME SCHEDULE OF HEAVY REPAIRS (CONCLUDED).

Steam pipe bench work done.
Drilling and reaming completed.

TWELFTH DAY.

Engine wheeled.
Binders on engine.
Pistons ready.
Jacket on.
Exhaust pot on.
Steam pipes in.
Steam pipes tested.
Air pump up.
Motion work up.
Cab fittings ready.

THIRTEENTH DAY.

H. P. cylinders on.
Cab fittings on engine completed.
Pistons in engine.
Valves set.
Ash pan up.
Front end and door on engine.
Rods ready.
Tank ready.
Brake bench work done.
Grate rigging up.

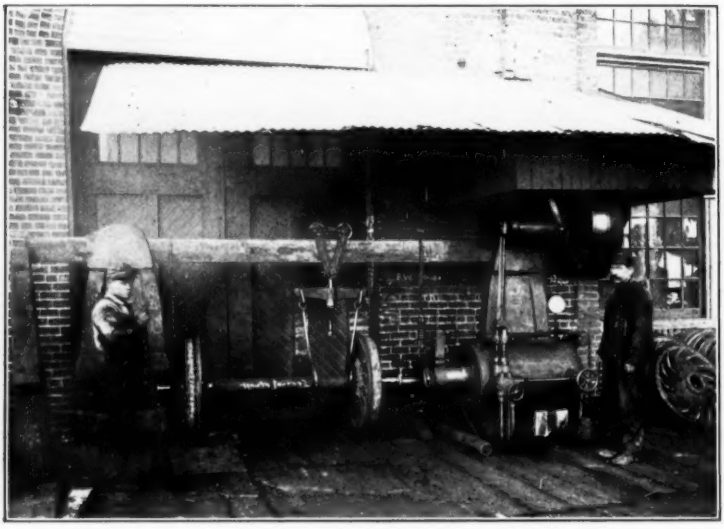
FOURTEENTH DAY.

Rods on engine.
Pipe work completed.
Pilot and beam on engine.
Brake rigging up complete.
Engine out of shop.
Pilot braces, coupler, drawbar, etc., up.
Engine painted.
Front end in.

FIFTEENTH DAY.

Engine in service.

The peculiar feature which characterizes the Santa Fe methods, and which focalizes the interest that the road and its policies hold for students of efficiency in the manufacture of transportation, is the uniform standardization of all operations and all shop schedules for repairs to motive power and rolling stock, and the performance of all work for these accounts under the efficiency system of bonus payment. This covers comprehensively work done in round house, machine shop, erecting floor, blacksmith shop, boiler shop, paint shop, coach shop, car shop, tin and pipe shop, and coppersmith work. About 23,000 operations in all departments are now recognized as standard, but additions are being made. The plan of standardizing these operations contemplates (1) a complete and permanent numbering system; (2) a practical arrangement of the numbered schedules in logical sequences; (3) a complete description of the work included under each schedule in language upon which only one interpretation can be placed; (4) a complete set of sketches showing the construction of all parts, for the instruction of timekeepers, foremen and workmen; (5) a substantial make-up and satisfactory method of reproducing the schedules; (6) a central organization having entire charge of all schedules. While the plan is now in effect in all the departments mentioned above, the schedules are not fully standardized except in round house, car shop and coach shop, the standardized schedules in these three departments numbering about 3,500, 5,000, and 1,500 respectively. The perfection of schedules in standard form, however, is progressing rapidly in other departments, about 25 per cent being now standardized in the erecting shop and from 15 per cent to 20 per cent in the boiler and blacksmith shops.



JAPANESE WORKMAN OPERATING WHEEL PRESS, RICHMOND, CAL.

This work is evidently enormous, and its achievement required courage as well as clear vision and firm grasp of organization principles. The problem was confused by the many engine types and the extraordinary large number of engine classes in the service of the system. Its physical and financial history—the diverse requirements and provisions of the various lines now combined under one management—have assembled and passed on to the present organization a collection of motive power which, with the newest and latest engines specially developed for present needs, make a grand total of some 150 classes. As preliminary to the preparation of the roundhouse schedules, these many classes were segregated into twenty groups, each group combining those engine classes sufficiently alike to make corresponding jobs practically identical for every engine in the group. The standard roundhouse schedules are designed to cover in detail all work incident to maintaining engines in road service. The wording is made as complete and comprehensive as possible, and as brief as is consistent with clearness. The operations are arranged under general heads, and the schedule number indicates the class of work covered, whether this be a detailed outline for some job of engine handling such as wiping, or whether it cover specific work, as on cylinders, injectors or rods, etc. The schedules are standard throughout the system, but for convenience each shop point is given a number

Form 2504 Standard

Santa Fe

ROUND HOUSE WORK SLIPS

Engine No..... Date.....

Block No..... Schedule No.....

O. K..... .....

Foreman

*The Engineering Magazine*

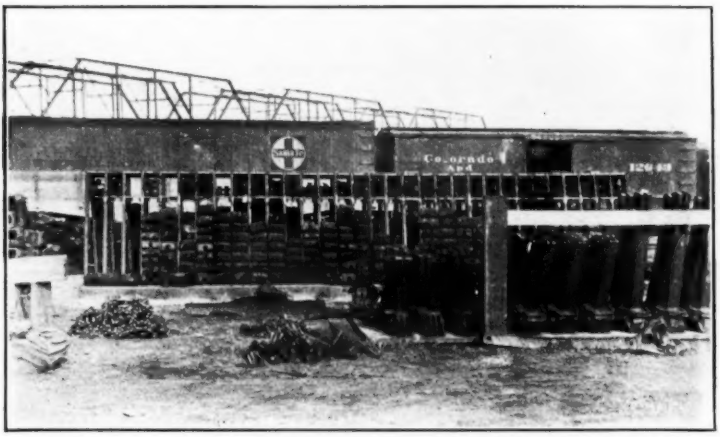
ROUNDHOUSE WORK SLIP FOR ENGINE REPAIRS.

Made out by roundhouse foreman on arrival of engine and examination of engineer's report, one slip for each operation necessary. Original given to workman as authority for job; carbon duplicate remains in foreman's book. Slip is turned over to time keeper when work is completed. Forms are 5 by 4 in., one white and one yellow.

which is prefixed to the schedule number. In the example given below "62" indicates the San Bernardino roundhouse. Capital letters following the conclusions of the schedule indicate the groups of engines to which the times in the extreme right-hand column apply.

STANDARD ROUNDHOUSE SCHEDULES.

| Subject. | Schedule Number. | Operation. | Groups of Engines. | One-Man Time. |
|---|---|---|---|---|
| Wiping.. | 62-0085 | Wiping machinery below running board, including pilot, engine trucks, cylinders, steam chests, guides, crossheads, rods, driving wheels, brake cylinder and rigging, air pump and piping, eccentrics, straps, blades and motion work, rocker boxes and valve rods and everything below the running board not specified..... | ABCDEG ..... | 1.5 |
| | | | HIJKL ..... | 1.5 |
| | | | MNPRSV ..... | 2.7 |
| Cylinders | 62-0425 | R & R, H. P. cylinder, including renewing H. P. and L. P. valves and cylinder packing. All work necessary ..... | PN ..... | 36.0 |
| Injectors. | 62-0855 | Overhauling one injector complete ..... | ..... | 1.6 |
| Rods..... | 62-1262 | Reducing, refitting and lining back end outside main rod brass. | ABCDEGHJK .. | 1.6 |
| | | | FLMNRSTUVX. | 2.6 |
| | | | P ..... | 3.2 |



KNUCKLE AND COUPLER ATTACHMENT RACKS, LOS ANGELES REPAIR TRACKS.

The many slightly differing types are assorted, separated and marked, so that delays in finding any needed part, or mistakes and troubles from taking the wrong one, are prevented.

The method of numbering shop schedules, as distinguished from roundhouse schedules, embodies a different and a more interesting purpose. A combination of figures and letters is employed to define the shop, the class of work, the kind of job, and the serial definition of the individual schedule defining the work embraced. Thus in the sample number 1A1-72, 1 indicates the erecting shop; A, cylinder work; 1, cylinder castings; the hyphen separates the integral part of the symbol from the schedule serial; 7 refers to saddle, and 2 to laying off. The initial figures representing the shops in which the work is done are:

1 Erecting Shop
2 Machine Shop
3 Boiler Shop
4 Blacksmith Shop
5 Tin Shop
6 Pipe Shop
7 Paint Shop
8 Carpenter Shop

The classification of work distinguished by the letter occupying the second place in the symbol is illustrated by the following:

LOCOMOTIVE CLASSIFICATION.

A Cylinders.
B Frames and Braces.
C Valve and Valve Motion.
D Guides and Pistons
E Main and Side Rods.
F Driving Wheels and Boxes.
G Carrying Gear.
H Air-Brake Mechanism.
J Driver and Truck Brake Rigging.
K Steam and Dry Pipes.
L Leading and Trailing Trucks.
M Boiler Mountings.
N Wood Work and Cab Work.
P Boiler Complete.
Q Boiler Shell.
R Fire Box.
S Flues.
T Smoke Box.
U Tender Complete.
V Tender Body.
X Tender Brakes.
Y Tender Trucks.
Z Miscellaneous.

As all schedules covering work of the same class bear the same classification letter (A for instance identifying all work on cylinders, E all work on rods, R all work on fireboxes, etc.) it is very easy to assemble work of any class from all shops; and as the schedules are standard all over the road, the comparison between different points is exceedingly simple and rapid. When times vary for the same schedule on different classes of engines, this is properly indicated under the schedule itself. Examples of standard schedules in erecting, machine, blacksmith, coach and car shops are given below:

STANDARD MACHINE-SHOP SCHEDULES.

| Subject. | Schedule Number. | Operation. | One-Man Time. |
|---|---|---|---|
| LATHE. | | | |
| Piston Head, Air Pump .. | 2H10-57 | Making complete out of new casting, one new air pump piston head. Includes boring, threading, turning, grooving and finishing complete, for 11" air pump..... | 2.5 |
| Rods ..... | 2D10-51 | File and polish old piston rods when no cut is required. Class 256, 800, 1000, 566, 789..... | 0.5 |
| BORING MILL. | | | |
| Piston Heads.. | 2D4-46 | Turn, face, bore and cut grooves in one cast iron high pressure piston head, Classes 900, 789, 885, 1000 and 1050 ..... | 2.1 |
| PLANER. | | | |
| Driving Boxes. | 2F3-16 | Face one hub each, on four new cast iron driving boxes when only one side is to be faced, including one rough cut and one finishing cut..... | 1.8 |
| DRILL PRESS. | | | |
| Corner Irons.. | 2Z5-67 | Lay off and drill 13/16" holes in ½" x 12" faces of four channel irons, 104 holes ..... | 1.4 |

STANDARD ERECTING SCHEDULES.

| Subject. | Schedule Number. | Operation. | One-Man Time. |
|---|---|---|---|
| CYLINDERS. | | | |
| Applying H. P. Tandem Comp. ..... | 1A1-41 | Applying H. P. cylinders, fitted up, includes grinding in joints on intermediate and H. P. cylinder heads, bolting up head and H. P. cylinders, putting in piston and applying intermediate packing, grinding in and applying outside steam connecting pipes.<br>1—Classes 564, 825, 988:<br>a—One cylinder .....<br>2—Classes 900, 987, 1600:<br>a—One cylinder ..... | |
| Bushings, Chipping Ports... | 1A10-12 | Chipping and filing all steam ports on one cylinder bushing, all sizes, after ports have been drilled.....<br>1—All Classes:<br>a—per bushing ..... | |

STANDARD BLACKSMITH SCHEDULES.

| Subject. | Schedule Number. | Operation. | One-Man Time. |
|---|---|---|---|
| RODS. | 4E2-1 | Weld jaw end on side rod. Includes laying out, taking heat, welding, and dressing ..... | |
| | | 1—Classes 2355 ..... | |
| | | 2—Classes 789, 825, 900..... | |
| MOTION WORK. | 4C2-1 | Draw out, and forge rocker arm end on one valve rod, includes laying out, and taking heats ..... | |
| | | 1—All classes: | |
| | | a—One rod ..... | |

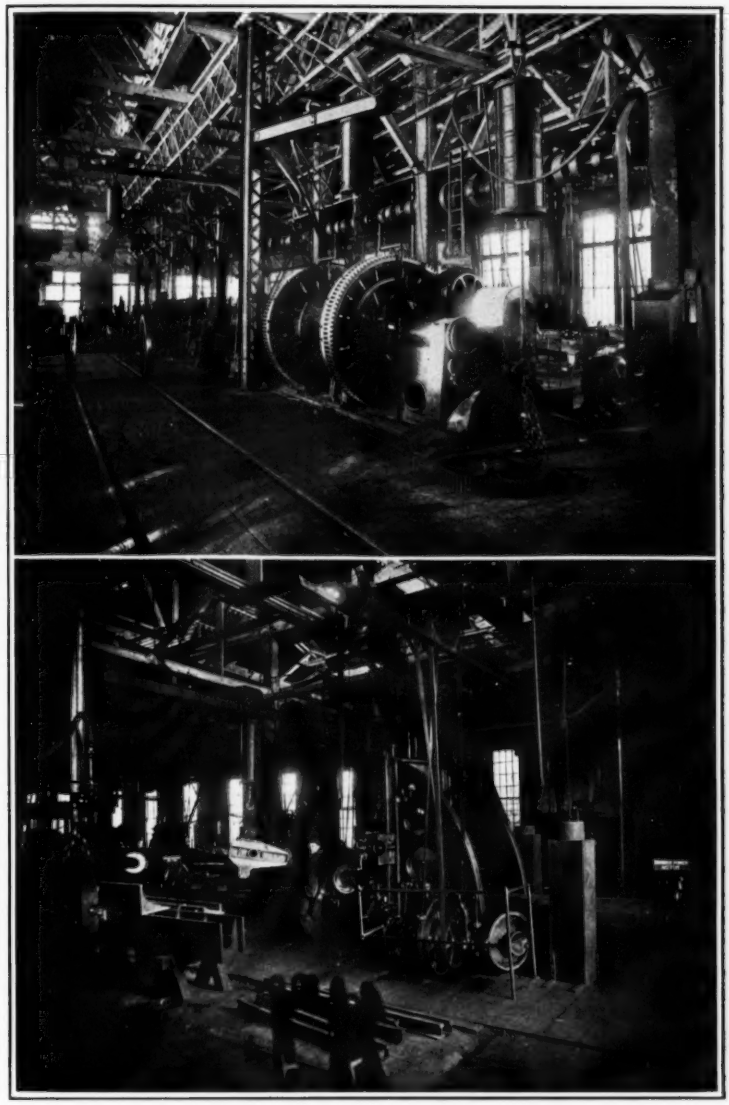
FREIGHT-CAR REPAIR SCHEDULES.

| Subject. | Schedule Number. | Operation. | One-Man Time. |
|---|---|---|---|
| Beams ..... | A-35 | Beams, cross tie, between side plates on ballast cars, includes all necessary fitting ..... | 1.5 |
| Brake Rigging. | A-158 | Brake cylinder block removed and renewed, when cylinder has been removed ..... | 0.5 |
| Lining ..... | A-535 | Lining, end or side, removed and renewed, per square foot..... | 0.04 |
| Rods ..... | A-764 | Rods, body truss, removed and replaced (whole rod), all classes..... | 1.5 |

COACH REPAIR SCHEDULES.

| Subject. | Schedule Number. | Operation. | One-Man Time. |
|---|---|---|---|
| Repairing Ceiling ..... | 0163 | Ceiling, applied, per square foot, when more than six feet are applied, including cutting to length..... | 0.08 |
| Doors ..... | 0228 | Door, sliding, on baggage cars or doors of similar construction, scraped and dressed after paint has been removed ..... | 2.0 |
| Molding ..... | 0457 | Molding, window, fitted, stenciled and dressed, including all classes of coach window molding, per piece..... | 0.1 |

Standardized wording of these schedules is considered to be of the utmost importance, as by this means the scope and character of each operation is precisely defined, and exact comparison between performances of the same operation in different shops is permitted. Variations, or defects of practice, methods, or machinery are thus made immediately apparent, and may be investigated and corrected. The standard wording is therefore fixed with great care. When the language of any given schedule has been brought to apparently satisfactory preliminary draft, it is submitted to the supervisors in the various shops of the system and their suggestions are carefully considered before the final form of the wording is adopted. Local conditions are thus taken into account, and provision is made, where



ALBUQUERQUE SHOPS, SHOWING THE MANY LARGE AND POWERFUL AIR HOISTS FOR HEAVY MACHINE WORK.

Very handy, saving much labor, and involving but small surcharge or burden expense.

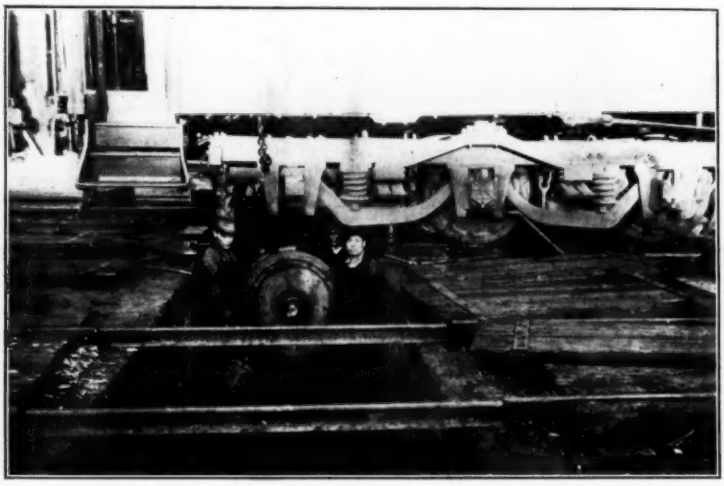
LA JUNTA (COL.) SHOPS, SHOWING CRANE EQUIPMENT.

An exceptionally well laid out repair shop of moderate capacity; has turned out more than 35 engines (heavy and general repairs) per month. The transfer of locomotives for transverse pits is made on a table outside, but the crane lifts cabs, domes, front ends, superheaters, etc., and will even lift the front end of a small locomotive so that trucks may be taken out. Surcharge and operating cost of such a crane are small.

necessary, to allow for them. For example, stripping an engine which is to be handled by a crane (as at Topeka) may involve the removal of parts that need not be taken down if the engine is to be handled by a hoist, as at Albuquerque, or San Bernardino. Standard schedule for stripping, then, will cover only the work common to both cases; a supplementary schedule will provide for the remainder. This supplementary schedule, though applicable only to shops equipped with cranes for locomotive handling, nevertheless will appear in its standard language in the schedule books for all shops; but where no crane is installed, no time will be fixed for the schedule. The standard time will be inserted if and when occasion arises through installation of a crane.

SANTA FE TYPE FREIGHT ENGINE ON KNOCKDOWN TRUCKS, SAN BERNARDINO SHOPS.
These trucks allow repairs to be made without the use of blocking; they consist of three pieces—a strongly riveted frame of old channel iron, and truck wheels in free bearings; they are easily knocked down for storage.

The great purpose of this standardizing, both as to operations and times, is to place all work under the "efficiency system" of bonus award, which is perhaps sufficiently well understood to need no extended explanation here. Under this method, employees are paid by day wages, but are stimulated by an additional bonus proportioned



JAPANESE CAR REPAIRERS APPLYING WHEELS, LOS ANGELES REPAIR TRACKS.
With this simple drop pit the cost of removing and applying one pair of wheels is reduced to 85 cents.

to their efficiency over a considerable period of time (usually a month); efficiency in this sense being the ratio between the actual record of the man, or the time he takes for a series of jobs, and the standard or schedule set for him. The amount of the bonus is determined by a standard table fixing the percentages of wages for time actually worked which is paid in addition as bonus at any determined rate of efficiency. This table grants no bonus below 66⅔ per cent efficiency—that is, below the rate of working at which the man takes 1½ the standard time for completing his job; but from that point upward it allows bonus on a rising scale, which reaches 20 per cent additional to actual wages at 100 per cent efficiency (or the completion of the job in the standard time) and thereafter adds 1 per cent of wages as bonus for each additional 1 per cent of efficiency. The estimation of bonus by continuous record over a month's work, instead of by separate jobs, encourages men and foremen to plan ahead and to arrange their work to the best advantage.

The fixation of standard time for each operation is manifestly of importance equal to that of standardizing the operation itself. Great care is exercised in this part of the work to weigh and to allow for all conditions and possible interferences. Past experience is not the only guide, nor is the ability of the fastest worker taken as the standard, for this would dishearten men who could not possibly reach

his extreme facility. Conditions of environment or equipment tending to prevent high efficiency are diligently sought out and remedied. It is made possible, so far as lies in the power of the management, for the men to work at high average efficiency. And in the final fixation of time schedules for each shop, local conditions (material, mechanical, personal) are given their full weight. Therefore, while any given schedule in the 25,000 already referred to is identical in language and in interpretation for every shop to which it applies, the standard time set for its performance might be different in each of these shops, according to local circumstances and facilities. These varying times are designed to express and to embody, for each shop, its own special advantages or disadvantages of machinery, appliances and labor, and by the arithmetical inequality of the time figures, to put the shops on an actual equality as to the bases from which their efficiency is reckoned.

Times are generally on a one-man basis; if several men are engaged on any job, the time is cut proportionately. It does not always hold true, of course, that four men (say) can finish a job in one-fourth of the time required by one man; they may take less or they may take more than one-fourth; nevertheless, the ratio is fairly true in the average, and its systematic application tends naturally to make foremen and workmen co-operate in keeping the most economical

BOLT CUTTER FOR WORKING OVER SCRAP, NEEDLES (CAL.) CAR DEPARTMENT.
An efficient device made in the shops from an old air-brake cylinder. Installed near rip track to save time running to the shop.

AN INSTANCE OF THE DEVELOPMENT OF EFFICIENCY UNDER THE BONUS SYSTEM ON THE SANTA FE, NEEDLES SHOPS.

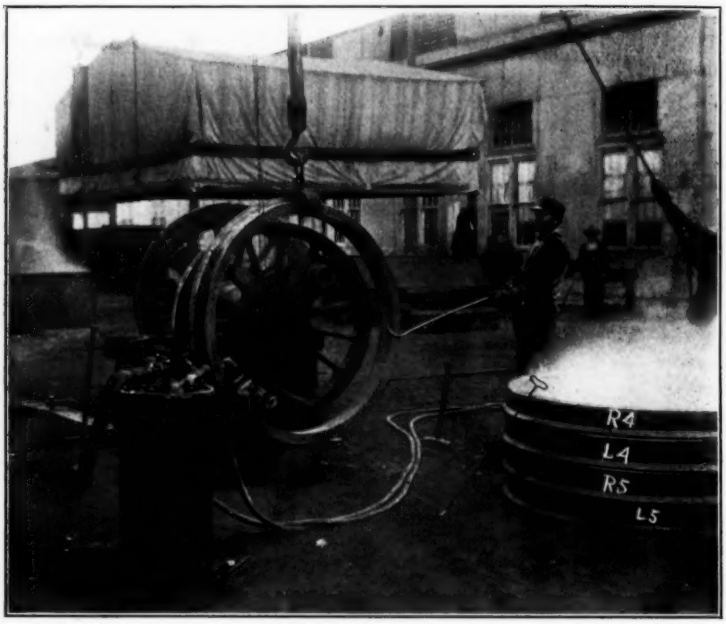
The operation is renewal of valve and cylinder packing in a tandem-compound engine, necessitating swinging the high-pressure cylinder out of the way to get at the low-pressure. Formerly this took 35 to 40 hours, holding the engine out of service 3 to 4 days. The job is now completed in an average of 8 to 9 hours. The mechanic and helper shown are holders of the record. Note the small jib cranes on the front end of the locomotive—characteristic equipment of the heavy power on the Santa Fe.

force employed under each schedule, because there will be fewer to divide the bonus. If a man is employed for part of the time on one job and then moved elsewhere, his efficiency for the part job is determined by the total time taken by the gang.

ECONOMICAL PERFORMANCE OF BLACKSMITH WORK, LOS ANGELES.

A small forge placed near the freight-car repair tracks is served by a Japanese smith and helper at 23½ and 17½ cents an hour, respectively.

An exception to the one-man time basis is made in some departments of the shops. Where work is so varied and detailed in character that individual schedules with minute record of operations are impracticable, or would involve an outlay of time and work wholly disproportionate to the small possible gain, "pooled schedules" are in use. These are based on careful and accurate time study of operations performed by a group of men, and a standard time is thus fixed for calculation of bonus. An example is afforded by the schedule for handling engines at the Richmond, Cal., roundhouse. Standard time of 3.2 hours is allowed for all work necessary to give an engine proper care when it is turned at this terminal, and a bonus is paid to the hostlers, hostlers' helpers, boiler washers, sandhouse men, and call boys, according to the ratio of standard hours to the actual work hours for each month. The standard efficiency table is used to

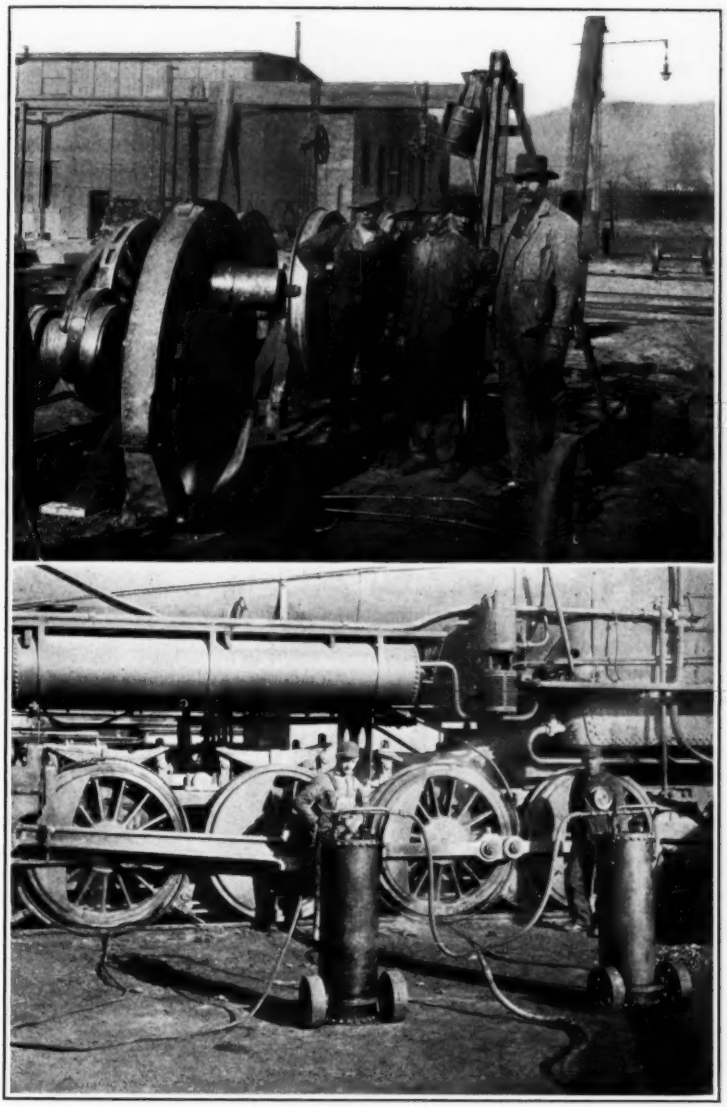



HEATING A COMPLETE SET OF TIRES FOR PLACING, BY USE OF A CRUDE-OIL FIRE, SAN BERNARDINO.

Removing and replacing a set of six tires by the old method took 36 hours, used 60 gallons crude oil, and cost $10.32. The new method requires but 22 hours, uses 20 gallons gasoline (for removal) and 12 gallons crude oil (for replacing) and costs $6.49.

compute this bonus, which is then divided among all the men according to the wages earned.

Mechanical operations are reduced so far as possible to units—so much time per inch of drilling, per 100 inches of chipping or caulking, per 100 flues cut out, or per 100 rivets driven. By building up total times with these units, or by applying the units in connection with standard job schedules, remarkably close provision can be made for the apparently complex and difficult work which may be necessary, for instance, in stripping and repairing a wrecked locomotive or car. For example, the job of taking out a locomotive frame may be standardized and scheduled. Special difficulties not contemplated in the schedule, such as stuck bolts which have to be drilled out, will be cared for by applying separately one of the unit schedules for bolt drilling at so much per inch. As both the main and the auxiliary schedules are bonused, the workmen have an incentive to exercise



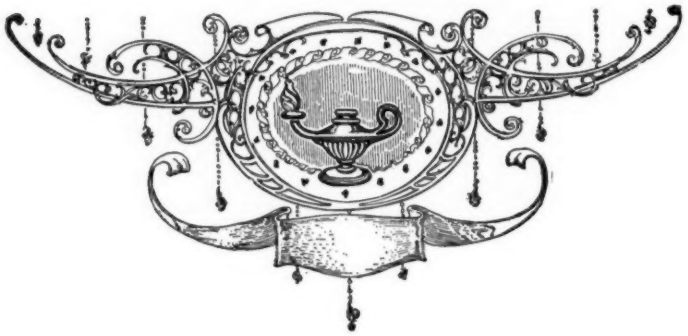
VARIOUS METHODS FOR PLACING AND REMOVING TIRES.

The lower view shows a very convenient application of portable gasoline tanks and burners, used at Winslow, Arizona. The upper one illustrates a burner using crude oil, with a shield to carry the flame around the tire, in use at Raton; total cost, labor and material, 11 cents per tire.

their best judgment and foresight in preparing for and meeting the conditions and in accomplishing the results with the highest efficiency and in the most economical way.

An important feature of the Santa Fe schedules, which will have become apparent from the illustrations and examples given, is that while they specify exactly what work shall be done they do not so rigidly define methods for doing it as to sterilize initiative and activity in devising improvements. On the contrary, marked individuality appears in the spirit and detail of management at the several larger shops. The policy of constant effort for improvement of efficiency is general; the performance by which results are accomplished reflects the personality of the local officials. Some of the illustrations accompanying these articles illustrate very interestingly these diversities of method for performing the same operation in different shops. The aim of the mechanical department is to foster all promising effort of this kind, and when a local shop devises a new economy to adopt it and make it standard for the road.

Alert and consistent administration of the system according to this principle will surely result in a continuous betterment of shop practice and progressive lowering of maintenance costs, while frank and fair recognition of the sources of such improvements will provide the best possible moral stimulus to the personnel of the mechanical department.



# GEORGE WALLACE MELVILLE.

## REAR ADMIRAL UNITED STATES NAVY, RETIRED, ENGINEER IN CHIEF OF THE NAVY FROM 1887 TO 1903.

*By Walter M. McFarland.*

Mr. McFarland was in the United States Navy from 1879 to 1899, during which time he rose to the rank of chief engineer and (by passage of the Personnel Bill) lieutenant, U. S. N. He was twice assistant, and once principal assistant, to Admiral Melville. He writes, therefore, as one who best understands the service the Admiral has rendered, and who stood closest to and knows intimately the man to whom this tribute is paid.—THE EDITORS.

THE frontispiece of the Magazine this month is a reproduction of the portrait by Ivanowsky which is to be presented to the National Gallery on May 6, by many of the friends and admirers of Admiral Melville. Ever since his retirement from the office of Engineer in Chief of the Navy in 1903, there has been a feeling among his friends that they wanted to put in permanent form a tribute to his magnificent record, of which the profession is proud. Those who know Admiral Melville intimately believe that his face is a thorough index of his character and that no reader of physiognomy could be with him long without realizing that he was in the presence of a strong man capable of great deeds. The photograph cannot, of course, fully reproduce the portrait, but those who have seen the latter say that it is a great credit to the artist, for it brings out Melville's remarkable traits of character so well that, as the years go by, those who read of what Melville has done will see, when they look upon his picture, that this was the record to be expected of such a man.

Although Admiral Melville retired from active naval duty in 1903, he has not been idle since, and maintains his close touch with engineering matters, so that a brief sketch of his career merely brings the salient features before those who have known them all and perhaps recollect them quite as well as the writer.

He entered the navy at the beginning of the Civil War and before its close had made a record as a highly competent engineer and a man who did not know what fear or danger meant. The older officers in the engineer corps had already marked him as a man whom they

always wanted to have with them, and he was, in fact, always selected for duty which required ability, resourcefulness, and courage.

His name became known throughout the world for his heroic work in the Lena Delta, in connection with the retreat from the Arctic steamer Jeannette and his search for the bodies of his missing comrades. Those who have never read his straightforward and unpretentious book, called "In the Lena Delta," not only have a treat in store for them, but they have little idea of what tenacity and courage can accomplish in the face of almost insuperable obstacles. This was not his first Arctic experience, as he had gone on the Tigress to the relief of the Polaris expedition; nor was it his last, for he was chief engineer of the Thetis which rescued Greeley and his companions.

After his return from the Arctic, he was assigned to special duty, mostly in the development of new devices and the trying out of new ships—always duty of an arduous nature—and at the beginning of the Whitney administration he was the inspector at Cramp's shipyard. It so happened, just at this time, that Loring, who was Engineer in Chief of the Navy, was about to resign the office, and Melville was offered the position and accepted, entering upon his duties in the summer of 1887.

This was practically the beginning of the modern navy of the United States, although the Roach cruisers had been completed before; to a man of high professional ability, originality and courage, it presented a splendid opportunity for making a great reputation. It is not necessary to say that such a reputation was attained early in his administration, for Melville's name has been known in engineering circles throughout the world for the last twenty years as one of the great leaders of the profession. Space will not permit me to detail the various triumphs of his administration, but it may be remarked that he gave the country the two fastest large vessels in the world in the Columbia and Minneapolis, whose record was not equalled for nearly a decade. The great majority of the vessels of the existing navy owe their machinery designs to him, covering about 120 vessels of all classes and about 1,250,000 horse power.

Melville's whole career showed progressiveness of the right kind. He wanted what was new and best, but he was not carried away by mere novelty. He was strong enough to decide on lines of action which often alarmed men of less courage, but he was also strong enough to refrain from doing what would insure temporary applause, when his judgment told him that the matter was still experimental. This was the case with water-tube boilers. He was the first to use

them in large vessels, and after their successful introduction on the Monterey, there was a natural temptation to go on with the work and receive the applause which would certainly have come. He felt, however, that sufficient experience had not yet been obtained, and he waited until he was satisfied that it was wise to use them generally. Meanwhile, in the navies of some other nations that began later than he, the use of those boilers was pushed much more rapidly and as a result mistakes were made that were expensive and caused much bitter controversy.

Like all really strong men, Melville is honest, straightforward and kindly in his intercourse with everybody. The young men whom he gathered around him as assistants looked upon him more as a father than as a military superior, and there was nothing he could call upon them to do that they did not count it a pleasure to perform. He is a very affectionate man, notwithstanding his frankness which leads some who do not know him well to think him blunt. After his return from the Arctic, he always looked after the men who had been with him, and from those in this humble position up to the famous people who are his friends, every one who is worthy is sure of a steadfast place in his affections.

There have been three great names in the history of naval engineering in the United States: Haswell, who founded and developed the engineer corps; Isherwood, who was responsible for the machinery during the Civil War and who did such splendid experimental work; and Melville, who built up the machinery of the present fleet. Haswell lived to the great age of ninety-eight; Isherwood is still with us at a little less than ninety; Melville, compared to them, is a young man. It is the fervent hope of his many friends, and indeed of the entire engineering profession, that he may be spared to the same great age as these other two famous men, to enjoy the love and admiration of his countrymen to whose service his life has been given, and from whom he both merits and receives a tribute of praise, of which this portrait is the evidence.

# EDITORIAL COMMENT

### Railways and Forest Fires.

THE Public Service Commission of the Second District of New York has ordered the use of oil-burning locomotives on railway lines through the Adirondack forest reserve, as a means of reducing the loss from preventable fires. About 40 per cent of the whole destruction in the autumn of 1908 is said to have been traced, by testimony before the Commission, to locomotive sparks or dropped coals. The proposal of the railways to provide additional safeguards on stacks and ash-pans, to clear combustible matter from the right of way, to establish a competent fire patrol and a telephone system of communication, and to equip and keep ready a service of fire-extinguishing trains, was regarded by the Commission as inadequate. Unless these supplementary measures are taken, however, it is to be feared that the results will be disappointing.

Where oil-burning locomotives are in regular service, even under management marked by more than usual care as to condition and operation, they have not proved at all blameless in the matter of setting fires. Little pieces of detached carbon or firebrick, or vegetable matter in the sand used for the necessary and frequent sanding of flues while these engines are running, or leaks of oil from the tank or piping at other times, attach to this type the very dangers it is sought to avoid.

An alert and conscientious patrol with coal-burning engines, would be even preferable to a lax patrol or none under a false sense of security following the use of oil burners. A responsible force, regularly paid, and rated by their efficiency in preventing fires, would show a wonderful improvement over the results secured by the long-established system, which pays certain sometimes doubtfully responsible men according to the time that fires actually continue to burn.

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### A Study of Efficiency.

MR. LEWIS B. STILWELL'S address before the joint "Conservation" meeting of the four National engineering societies of the United States, at the Engineering Building in New York a month ago, throws an interesting, and to many persons probably a surprising, light on the inefficiency of methods of which we have been quite unashamed—in which, indeed, we very lately rather gloried as typical of the age of steam and the era of machinery. The new point of view is obtained by getting into range Mr. Stilwell's figures for the total coal equivalence of the Niagara Falls Company's output (560,000,000 kilowatt hours in the year 1908) which he puts at 1,000,000 tons, and the coal saving due to centralizing the generating equipment in the Interborough Rapid Transit Company's plants; this he puts also at 1,000,000 tons in 1908, on an output of 409,000,000 kilowatt hours. The figures were arrived at by comparison of tests made on the Manhattan Elevated Railway before and after the installation of electric traction. In other words, the Interborough central stations, still burning coal, yet save as much coal, formerly wasted, as would suffice to operate a plant equivalent to the Niagara Falls Power Company's electric station — a plant 40 per cent larger than the Interborough power houses themselves. To put it in still different form, the coal conserved by the coal-burning Interborough plants is 140 per cent of the coal conserved by the water-driven Niagara plants.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

# THE BRITISH ENGINEERING STANDARDS COMMITTEE.

A REVIEW OF ITS HISTORY, ORGANIZATION AND ACHIEVEMENTS.

*Sir John Wolfe Barry—Institution of Engineers and Shipbuilders in Scotland.*

A LECTURE delivered by Sir John Wolfe Barry before the Institution of Engineers and Shipbuilders in Scotland on December 11, 1908, and published in *Engineering* for January 29, gives an interesting and comprehensive account of the history, organization and achievements of the British Engineering Standards Committee. For nearly sixty years following the publication of Whitworth's notable standards for screw threads in 1841, little effort was made in England towards the realization of engineering standards, though the benefits conferred by Whitworth's work were conspicuous and unquestionable. Since the beginning of the present century, however, the work of systematizing the details of engineering practice has been undertaken by a committee of the leading engineers and the most prominent manufacturers in the country. The results of their labors, a few of which are noted below, have been uniformly successful, and the movement has already produced most gratifying effects on both the commercial and technical sides of engineering.

Early in 1901 Sir John suggested to the Council of the Institution of Civil Engineers that some definite action should be taken by them to draft standard forms for iron and steel sections. At that time the number of rolls was immensely more than was really needed and, owing to the lack of standards, it was increasing continually without any real advantage. This want of system had three important results: unnecessary cost of articles, delay in production, and prohibition of the manufacturers from stocking during slack times any large quantities of material. Sir John's suggestion was not adopted by the Institution without considerable discussion, but finally, notwithstanding influential opposition to the principle of standardization, a committee was appointed to consider the subject, to which three sister societies, the Institution of Mechanical Engineers, the Institution of Naval Architects, and the Iron and Steel Institute, were invited to nominate representatives. The joint committee reported strongly in favor of the project, and the carrying out of the work was entrusted to a strong representative committee, formed of delegates of engineers from the four Institutions and of manufacturers. Later when the scope of the work of the committee was enlarged to include electrical subjects, the co-operation of the Institution of Electrical Engineers was secured. It has always been the policy of the committee to enlist the co-operation of the trade associations in the various branches of engineering with which they have been concerned; and the Government has co-operated to the extent of giving substantial financial assistance, adopting the standards so far as possible in Government work, and nominating the heads of the Government engineering departments to membership on

the committees. To the Main Committee thus constituted falls the duty of guiding and directing the work of standardization, the selection of the subjects to be dealt with, the passing of the reports and the raising of the necessary funds.

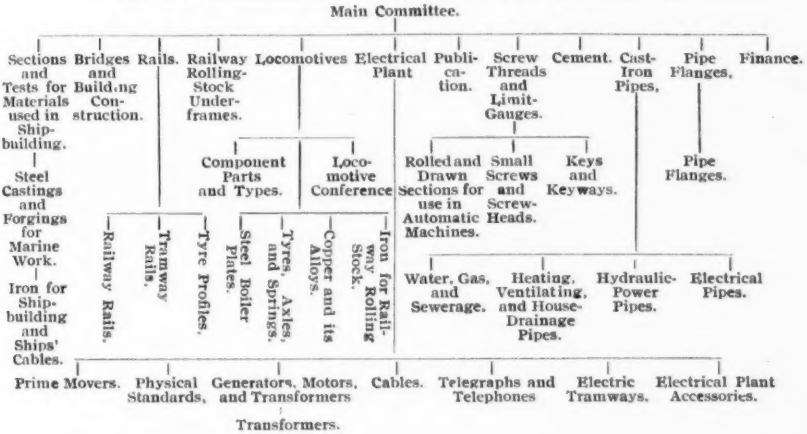
Very soon after the Committee began its labors it was apparent that many subjects outside of those of iron and steel sections were in urgent need of systematization; it was therefore decided to extend the scope of the Committee's work so as to include manufactures outside of those originally contemplated. It also became apparent that the engineering industry would profit considerably in many directions if standardization on a judicious scale were initiated in the nature of the materials as well as in the form of the manufactured articles. The work of standardization of forms and also of qualities and compositions has gradually grown to cover a very large number of branches of engineering work. At the present time the Main Committee has thirty-seven subjects under its guidance and control. A few more still remain to be added.

The Main Committee as a whole does not attempt to deal with the great variety of subjects presented to it for standardization. It has followed the practice of creating Sectional Committees, each of which is charged with investigating and reporting on a specific subject; these Sectional Committees in turn have the power of appointing Sub-Committees for dealing with details and sub-divisions of the subjects in question. The control of the whole work, however, remains in the hands of the Main Committee and no drawings or specifications can be issued without its final confirmation. There are now thirty-nine committees, with a membership of nearly 300. The diagram shows the relation of the Sectional Committees and Sub-Committees to the Main Committee.

The Committee as thus constituted has been at work for the last five years. Its standards in all the numerous branches of trade are gradually but surely finding their way into general acceptance and use throughout the country. The beneficial effects of its work are apparent in two general directions: in the first place, the Committee has afforded an impartial meeting ground where the different and sometimes conflicting interests of designer, purchaser and producer can be openly and thoroughly discussed, and, secondly, its labors have shown that there are many points in engineering manufactures which greatly needed further experimental investigation on scientific lines. The special inquiries conducted by the Standards Committee have been carried out in various manufacturing establishments throughout the country, or, when they entailed scientific investigations for which the manufacturers had not facilities, in the National Physical Laboratory.

The National Physical Laboratory has co-operated with the Committee in a great deal of very important work. Among the more important of its investigations may be mentioned a long series of experiments to ascertain the effect of temperature on insulating materials, an investigation of the relation existing between the mean temperature of a field coil and the maximum temperature of the hottest part of the same coil, and an exhaustive series of tests to establish standards of life and efficiency of carbon-filament glow lamps. A further set of electrical experiments are to be carried out on high-tension dielectrics, with the object of deciding certain vexed questions connected with the testing of electrical machinery. In the field of mechanical engineering, the Laboratory has assisted the Committee in fixing the standards of accuracy for running fits. It has also carried out the verification of the British standard templates for tramway and railway rails, and for the British standard pipe flanges. An arrangement has been made with the authorities of the Laboratory by which various sets of standard gauges shall be deposited there, to be available from time to time as reference sets for checking the working gauges of manufacturers throughout the country. So far, gauges for tramway and railway rails, fish plates and pipe threads have been deposited; standard gauges for caps of glow lamps and for the threads of spark-

PRESENT ORGANIZATION OF THE ENGINEERING STANDARDS COMMITTEE.




ing plugs of internal-combustion engines will shortly be available, and the system will be further extended in all directions.

Only brief mention can be made of the subjects Sir John Wolfe Barry selects as salient instances of the class of work done by the Committee. In the field of marine and naval engineering it has succeeded in drafting a set of standard sections and standard specifications for materials which have been accepted by Lloyd's and the other registry societies, as well as by the Government. Rolled sections for buildings and bridge work have also been standardized. The commercial advantage of standard sections is especially well illustrated in the case of tramway rails. Before the publication of the Committee's standards there were over seventy sections of rails in the country; this number was reduced by the Committee to five standard sections with five corresponding sections for use on curves. Over 80 per cent. of the total tramway rails now rolled are of these standards.

The standard specifications for Portland cement have been of great benefit both to the manufacturers and consumers. In the electrical field, besides cooperating with the National Physical Laboratory in the investigations already mentioned, the Committee has published specifications for the construction and testing of electricity supply meters which are doing much towards raising the standard of these instruments, to the advantage of both maker and user.

The Whitworth standards for screw threads have been extended to cover threads of finer pitches than those of the original Whitworth series. A series of tables has been drawn up showing the amount of variation allowable in nuts and on the corresponding spanners. The standards for pipe threads evolved by the Committee are to be definitely adopted by the tube trade on July 1 next. Besides the reference gauges for pipe threads deposited in the National Physical Laboratory, a travelling set of gauges is being sent to the manufacturers in various parts of the country for the purpose of checking the shop and working gauges. It is confidently hoped that by this means, in addition to interchangeability, a higher standard of accuracy of production will be attained.

The Committee has adopted a general rule that only materials and sections should be standardized, leaving to the engineer the decision as to how the standard forms and materials should be applied to solve the problems of whole structures or machines. In one notable instance, however, the Committee has departed from this rule. At the request of the Secretary of State for India the Committee has undertaken and completed the standardization of five distinct

types of locomotives for the Indian railways; four other types are now under consideration. Since 1905 nearly 1,000 locomotives of the British standard types have been built.

The Committee has been fully alive to the disadvantages which would result from injudicious or incomplete standardization; it is equally cognizant of the risk of impeding progress through the stereotyping of design. This latter aspect of the question the Committee has had continually before it ever since the beginning of the movement; it has taken adequate steps to perpetuate its organization and has evolved methods to provide from time to time for the consideration of each type drawing and specification, and for their revision if experience shows that revision is desirable.

## A NEW TEST FOR CONCRETE.

A METHOD OF DETERMINING THE EFFICIENCY OF THE MIXING PROCESS.

*J. S. Owens—Society of Engineers.*

SPECIFICATIONS for concrete construction usually state clearly the tests which the cement must satisfy, the exact nature and proportions of the aggregate, and the method of mixing which is to be used. The nature of the actual material is clearly specified in the case of each of the separate ingredients, but in the case of the concrete itself only the method of arriving at a certain result is prescribed. The omission of clauses covering the quality of the resulting concrete, which depends ultimately on the thoroughness with which the mixing process is carried out, is a weakness in ordinary specifications which may entirely nullify the care with which they have otherwise been drawn. Hitherto the omission has been to a certain extent excusable because of the lack of a reliable and rapid method of determining whether the mixing of concrete has been efficiently done; but a very simple and satisfactory test for this purpose has recently been devised by Dr. J. S. Owens, who describes it at length in a paper read before the Society of Engineers on March 1, of which the following is a brief abstract.

The methods of determining when concrete has been properly mixed, which have been used up to the present, are: (1) inspection of the mass, a crude and ineffective method, except for determining the distribution of water, on account of the impossibility of detecting by the eye alone any but very considerable variations in the proportions of different parts of a batch of concrete; (2) testing briquettes made from samples taken from different parts of the mass, a method sound in principle but useless as a field test on account of the length of time which must elapse before the result can be known; and (3) inspection of the distribution in the fractured surface of broken sample briquettes of a pigment added to the concrete, an ingenious method but one clearly not applicable to testing concrete in the field.

Concrete is properly mixed only when the various ingredients are as uniformly distributed as the size of the particles composing them will admit. To be practicable a test to determine whether this uniformity of distribution has been attained should show in some simple way whether small samples taken from different parts of a heap of concrete contain the same relative proportions of stone, sand and cement. "A knowledge of the different rates of settlement in water of materials composed of different sized particles, of the same specific gravity, suggested that this peculiarity might be utilized to separate rapidly the ingredients composing concrete. A series of experiments was undertaken to determine the practical value of the method. It was found that when a sample of concrete, freshly mixed, was placed in a tall narrow glass vessel nearly full of water and shaken up, on standing, the cement, sand and stone settled at very different rates. The large stones collected at the bottom; over them and clearly defined came a layer of sand; and over the sand a layer of cement, the lines

of demarcation being perfectly distinct. The next question was to determine whether the thickness of these layers was directly proportional to the amount of material present in the sample; if so, here was a method of telling at once whether each sample contained the same proportions. It was not essential to know the exact amount of material present in each layer, but simply whether the relative proportions were the same in each sample." The reliability of the test has been confirmed by a large number of experiments which are described in Mr. Owens' paper.

The rate of settlement of particles in water, if of the same specific gravity, is governed by their size. For particles over 0.0039 inch in diameter, the velocity of descent varies as the square root of the diameter; this is the law which governs the settlement of sand. Particles of cement which passes the fineness test prescribed by the British Standard Specifications (not more than 18 per cent on a 180-mesh screen) are, however, under this diameter; their rate of settlement varies with the square of the diameter, the viscosity of the liquid in this case controlling the velocity of descent. In a tube of sufficient height to effect a good separation, the falling velocity of the sand is about 30 times as great as that of the cement. To bring out the difference in the rate of settlement, a tall vessel is necessary, since the object is to make the time interval between the various sized particles as great as possible.

Cement reaches its final settlement very slowly. Even after the water has become perfectly clear the layer will continue to shrink for some little time. The measurement should be made, of course, only after the layer has reached its minimum thickness. The thickness depends to some extent on the time during which the cement is in contact with the water, owing doubtless to the reaction between the cement and the water; it is clear, therefore, that comparison as to the amount of cement present can only be made by this method when the samples are from the same mixing, though a few minutes more exposure in one sample than in another will make little difference. An error of much more importance is introduced if too small a quantity of water is used in the tube. The sand and gravel in settling entangle a certain amount of cement, which increases as the amount of water is decreased. The amount is negligible, however, when the column of water is at least four times as high as the column of concrete.

The strength of concrete depends practically on the strength of the mortar which cements the larger pieces of stone together. In determining proportions, the ratio of cement to sand will be fixed by the strength of the concrete required, and the amount of coarser particles of stone or gravel which may be added will be the largest amount which permits of complete separation of the individual particles by the mortar. An increase of the amount of mortar over a little more than sufficient to fill the voids in the stone or gravel does not mean any improvement in the strength or impermeability of the concrete. It is a well known fact that to mix mortar effectively requires more work than to mix concrete containing coarser particles. "It is therefore obvious that if, when mixing concrete, it can be shown that the sand and cement are thoroughly mixed together, we may feel sure that the coarser particles are properly distributed throughout the mass. The importance of this is that it removes a difficulty in the practical carrying out of the test, since it is unnecessary to measure the amount of coarse particles of stone in a sample if we can measure the sand and cement. If, therefore, the samples contain slightly different amounts of mortar, as may happen if we include the coarse particles in taking them, this will not affect a conclusion drawn from the relative amounts of sand and cement present in each. Again we may entirely remove the stones from our sample, as is convenient in dealing with concrete having a coarse aggregate, and test the mortar only, knowing that if it is well mixed the concrete is well mixed."

This method of testing has been used with complete success in connection with the construction of a large reinforced-

concrete building. The concrete was mixed by machine in the proportion of 4 cubic feet of gravel to 2 cubic feet of sand to 100 pounds of cement. The largest particle of gravel would pass a ¾-inch ring. The details of the tests were as follows: Two test glasses were used, having a diameter of 1.5 inches and a height of 13 inches; a funnel fitting into the top of the glasses was provided, and a conical wire screen fitting into the funnel; the screen had meshes about one-twelfth of an inch square, or 144 to the square inch. Two samples were taken in a small tin measure, containing 6.2 cubic inches, each being taken from a different part of the heap of concrete under test. The funnel with its screen having been placed over a test glass, a sample was emptied into the funnel, care being taken to wash out the last particle from the measure. A small stream of water was then allowed to trickle through the concrete, which was stirred vigorously meanwhile, with the result that all the cement and fine sand were washed through the wire screen into the test glass, and in about a minute the coarse stones were left perfectly clean in the funnel. These were thrown away, or retained for measurement if desired; and the test glass, having been filled to within about an inch of the top with water, was shaken and placed to settle. The sand commenced to fall immediately and was all down in a few seconds, leaving the cement in suspension in the water; the cement then gradually settled down, and in about 10 minutes reached a layer of minimum thickness. The depth of the sand and cement in each glass was then measured. The consistency of the results given by the test is illustrated by the following table:

TABLE SHOWING RESULTS OF TESTS ON MACHINE-MIXED CONCRETE.

| Time required to empty feed into drum. hopper Seconds. | Time of mixing after whole in drum. charge was Seconds. | Sand. Thickness of Layers. Tube 1. | Sand. Thickness of Layers. Tube 2. | Cement. Thickness of Layers. Tube 1. | Cement. Thickness of Layers. Tube 2. | Ratio $\frac{S}{C}$ Tube 1. | Ratio $\frac{S}{C}$ Tube 2. | Time of Discharge. |
|---|---|---|---|---|---|---|---|---|
| 30 | — | 1.2 | 1.2 | 2.0 | 2.2 | 0.60 | 0.55 | Six seconds per barrow, or one-third of a charge |
| 20 | 10 | 1.0 | 1.0 | 1.7 | 1.9 | 0.59 | 0.53 | |
| 25 | 20 | 1.3 | 1.3 | 1.9 | 1.9 | 0.68 | 0.68 | |
| 30 | 30 | 1.0 | 1.0 | 1.8 | 1.8 | 0.55 | 0.55 | |
| 25 | 35 | 1.4 | 1.4 | 1.9 | 1.9 | 0.74 | 0.74 | |

## STORAGE BATTERIES IN ELECTRIC POWER TRANSMISSION.

THE ECONOMY OF ACCUMULATOR SUB-STATIONS AT DISTRIBUTION CENTRES.

*A. M. Taylor—Institution of Electrical Engineers.*

THE advantages of storage batteries for equalizing fluctuating loads in isolated electric-power plants are well established, and their installation has received the sanction of very wide application. Mr. A. M. Taylor believes that accumulators have no less important an application for equalizing loads on long transmission lines. In a paper read recently before the Birmingham Section of the Institution of Electrical Engineers, published in *The Electrical Engineer* for March 12, he advocates their installation on a large scale in sub-stations at centres of distribution, and shows the important reduction in first cost of the line which may be obtained by their use. We quote from his paper at length.

"The cost of long-distance three-phase overhead lines may be divided up into the cost of copper and the cost of supports. The capital cost of copper at £60 per ton, employing an initial voltage of 270 volts per mile of line, a current density of 250 amperes per square inch, and a combined drop of 35 volts per mile, amounts to, roughly, £20 per effective kilowatt transmitted, assuming power factor equal to 80 per cent. On a 100-mile line this would mean an initial voltage of 27,000, a total combined drop of 13 per cent. and a capital cost of £20 per kilowatt transmitted, which on a 25 per cent. load factor, and taking interest, sinking fund, maintenance, and depreciation at 25 per cent. per annum, would mean a charge of roughly ½d. per unit

transmitted. By increasing the length of line to 122 miles, the line voltage being kept at 27,000, the capital cost per kilowatt would be increased to £30 per kilowatt transmitted.

"So much for the copper part of the line; now for the supports. For light lines we may, perhaps, take £200 per mile as a minimum figure, while for heavy lines £500 per mile may be easily reached, excluding wayleaves. Assume the power delivered to receiving end of line to be, say, 10,000 kilowatts; this would require the heavier line construction, but, on the other hand, the cost per kilowatt would come out less than if we took a much lighter line, suited to the cheaper posts and insulators. A line 100 miles long would, therefore, cost £50,000, or £5 per kilowatt transmitted for the capital cost of poles and insulators. The smaller line, for, say, 1,000 kilowatts, would have cost £20 per kilowatt transmitted, for the same items. It will be evident that on copper figures, and with a limit of 27,000 volts and 10,000 kilowatts, 100 to 120 miles is about the economical limit for the bulk of the transmission, and 50 miles with 1,000 kilowatts, except where coal is very dear. It will be granted that any means which would halve the cost of the copper in the line would virtually increase by some 30 to 40 per cent. the possible distance of supply (in bulk), and thus be extremely useful in bringing the water power—which is mostly in inaccessible spots—to the big towns, where there is a demand for the power. It will probably be also agreed that in many cases, especially where the line has to traverse mountainous districts for many miles, and is subject to interruptions through difficulties of inspection, etc., it becomes desirable to duplicate both poles and wires, and the cost of the line is thereby doubled.

"The author's proposal is that electrical storage on a large scale should be carried out at the distributing centres, the reliability of the line being thereby increased to an extent that would warrant a second line being dispensed with. At the same time, he hopes to show that it is not necessary to trade upon the latter assumption in order to show a case for storage. The batteries would be arranged to take up 50 per cent. of the peak, thereby halving the copper costs for the line. In the case of a 10,000 kilowatt, 122-mile transmission with a single line, it will be found that, without raising the E.M.F. or increasing the line drop, the radius of transmission can be extended to 165 miles for the same total capital cost of $30 + 6 = £36$ per kilowatt transmitted. To cover this distance, *with a single line*, and with the E.M.F. limited to 27,000 volts, would have cost, without storage, some £63 per kilowatt transmitted. The storage scheme is thus some £27 per kilowatt the cheaper, as far as the line is concerned. If the 122-mile line above considered had been run in duplicate, as regards the copper, only one line of poles, however, being provided, the radius of transmission could have been extended from 122 miles to about 230 miles without increasing the capital costs.

"It will, no doubt, be objected that the author has taken too low a voltage, and that 50,000 volts might with advantage have been considered. But against this it may be said that the higher voltage brings its own disadvantages, and that, where the line has to pass through damp or smoky districts, the higher voltage would be risky. Another point that makes for the reduction in voltages is the fact that the distributing part of the line not infrequently equals the transmitting part of the line in length or is worked at a lower voltage. Consequently, the total cost of the line and distributors will really be that of a line working at an average voltage much below that of the initial voltage; and any saving effected on the first part of the line is, in part, compensated by the cost of the extra step-down transformers and the higher insulation wanted throughout the high-tension section. In the example already considered the resistance loss would be 8 per cent., and with a current density of 400 amperes per square inch this might be run up to 16 per cent. With a battery at the distant end of the line a much greater resistance drop than 8 per cent. could be allowed in the line without the regulation of voltage being seriously affected; and it will probably

be conceded that, in most cases, a greater resistance drop will be considered preferable to the risks introduced by increasing the voltage. One disadvantage of the lower voltage would be the considerably increased reactance; but the reduced generator capacity caused by this can be eliminated at moderate cost.

"It will, of course, be understood that, whether 50,000 volts or 30,000 volts be employed, the percentage increase in the length of the line effected by the use of accumulators, for a given total copper cost, remains unaltered; but the item for supports is evidently greater, in proportion to that for the copper, with the higher voltage, and somewhat reduces the length that would otherwise be permissible. If, as suggested above, we take account of the much greater facilities for regulation provided by the employment of storage at the receiving end of the line, it will be found possible to double the resistance drop in the line and thus to roughly double the distance of transmission. Thus, the 122-mile single line considered *could be lengthened to 220 miles,* without any additional cost being incurred on the line, by the employment of storage; while had the line been originally laid out in duplicate (as far as the copper is concerned) it could have been extended to 304 miles for the same total cost in copper and supports.

"The author suggests that, considering the desirability of being able to shut down one half of the line copper for repairs to insulators, etc., it will often be found advantageous to provide the spare copper circuit, where there is no storage. With storage at the consumer's end of the line it is, of course, possible to deaden the line at certain times of the day without interrupting the supply. The batteries and auxiliaries required for storage can in most, if not all, cases be provided for out of the saving in generating plant, step-up and step-down transformers, turbines, head works, and buildings, only half the horse-power being needed that would otherwise be required. Where the heads of water are low the costs of the plant and head works run up rapidly. In some of the Swiss water powers, the average figure is about £73 per kilowatt. On falls such as these the saving in generating plant and head works would suffice to extend the line to no less than 210 miles without increasing the total capital cost of the scheme, as compared with a single-line 122-mile scheme without storage. The further extension, due to saving in line copper, has, of course, to be added.

"The cost of batteries to deal with a load curve of the type under consideration would be about £10 per kilowatt, to which about £3 10s. per kilowatt must be added for auxiliaries and accessories, on alternating-current systems. Where the batteries cannot be paid for out of the savings in generating plant, they must, of course, be paid for in part out of the line savings—that is, the full benefit of the increased lengths above indicated cannot be obtained. The advantage of having a stand-by at the consumers' end of the line, equal to the maximum capacity of the whole scheme for short periods, is one which, of course, cannot easily be expressed in monetary value, but is nevertheless very great. The savings on a large power transmission scheme by the introduction of storage are not confined to the items above considered, such fixed charges as wages, management, taxes, water-power, purchase rights, etc., being all reduced with the reduction in the rated size of the generating station and line; and these would, the author estimates, more than pay for the cost of maintenance of the batteries and auxiliaries.

"The author believes that similar arguments to the above will influence those power companies which have to cover large areas, in the direction of putting down accumulators at the distributing centres, or offering their customers such terms for current during restricted hours, for charging purposes, as will induce them to themselves put down accumulators. Take the case of a small town on the outskirts of a power company's area. If the power company has to run a special feeder out to that town, it may easily happen that the cost of that feeder, especially if in duplicate, may run into £10 or more per kilowatt of maximum demand, and if the load factor is

low this is a serious item. In this case the savings in fixed charges at the generating station would alone pay for the cells, and the saving in the feeder could be put down as clear profit. Or, again, a power company covering a very large area, and confined by lack of facilities for cheap power production to one part only of this area for its generating station, might find it practicable materially to reduce the costs of its general transmission and distribution system, as well as improve its reliability, by employing large batteries in its own sub-stations."

## REINFORCED-CONCRETE BARGES AND PONTOONS.

A DESCRIPTION OF SUCCESSFUL STRUCTURES BUILT IN THE TIBER, AT ROME.

*E. Lemaire—Le Génie Civil.*

ONE of the most curious uses to which reinforced-concrete has been put is its application in the construction of boats. The idea of utilizing the peculiar properties of this material in floating structures is by no means new; it has been proposed at various times since those properties became generally understood. The difficulties to be overcome were not great, but they were sufficiently numerous to prevent very rapid progress. For several years, however, the Gabellini firm of concrete contractors in Rome have been building in the Tiber reinforced-concrete lighters and pontoons which have given very satisfactory service. The following brief description of the structures is taken from an article by E. Lemaire in *Le Génie Civil* for February 6.

It is evident, of course, that the field of concrete in naval construction is very limited. It is applicable to boats which are intended only for short voyages or to floating structures which may remain stationary, in which a heavy shell is not an inconvenience and may even be an advantage. Stationary pontoons which may require ballasting, and lighters for loading and discharging ships are typical structures to which the material is well suited; they are indeed the only structures to which it has been applied. Lighters often have to be navigated light; a heavy hull gives a stability which adds much to the ease with which they can be handled. The deeper draught of reinforced-concrete lighters increases the resistance to towing, but its effect is largely counteracted by the lower coefficient of friction between smooth concrete and water, than between water and iron or wood.

The advantages of concrete as a material of construction for boats of this class may be briefly summarized. Marine growths cannot readily attach themselves to the smooth surface of the concrete. The boats are incombustible, they can be easily kept in a clean and sanitary condition, they are impermeable, imputrescible and not subject to corrosion by chemicals in solid or liquid form when loaded in bulk. Sea water has practically no effect on concrete if properly made and applied, as has been shown by M. Le Chatelier. Of the mechanical properties of reinforced concrete its resistance to shock and its elasticity make it particularly well adapted to the construction of boats. Boats with double walls are practically insubmersible and indestructible under the severest shocks. The ease and rapidity with which repairs can be made is another great advantage.

The cost of reinforced-concrete pontoons is between that of wood and that of iron pontoons. The former are much more durable. The first concrete pontoons were used in a floating bridge over the Po in 1900; they have needed no repairs since that time, though subjected to stresses from the impact of boats and ice which formerly destroyed wooden pontoons in five years. At least a hundred bridges of this type have been built in the valley of the Po.

The first boat constructed by M. Gabellini, with the exception of a small skiff built in 1897, was the *Liguria,* a 150-ton barge which has been in coal-carrying service in Civita-Vecchia harbor since January, 1906. Four other barges or lighters, with capacities ranging from 30 to 80 tons, are employed by a salt company in Sardinia. The method of con-

struction is as follows: a groundwork of bars, properly spaced, is first formed, and on it is spread either an iron screen of 5 to 10 millimetres mesh, or sheet metal. On either side a mortar, consisting of a slow-setting cement mixed with a silicious sand is applied with a trowel in layers. When the mortar has set, it is covered with a layer of a richer mortar which is rubbed with the trowel while hardening so that it is given a high polish. In boats of the largest size the hull is about 25 millimetres thick.

This method of construction avoids the necessity of using costly forms; on the other hand it requires materials of the best quality and a high degree of skill on the part of the workmen. It is, however, the only method which could be successfully used. The factor of safety necessary to ensure sufficient strength in molded concrete would increase the thickness of the hull to such an extent that the boat would be too heavy for use. Even built as described above, concrete barges are much heavier than iron boats of the same tonnage.

Reinforced-concrete boats may be built in any place, since they require no special material. Take, for example, the method of constructing a double-hull, 150-ton barge. The keel, including the stem and stern posts, consists of eight iron bars, 24 millimetres square, laid with ends overlapping. These bars are curved to the desired form and are held in their respective positions by iron wires. To the keel at intervals of 1½ metres are attached round iron rods which are bent to form the frame of the hull; they are held in position by longitudinal bars attached to their free ends. Further longitudinal reinforcement is attached to the frame at different heights. Over all, a 5-millimetre screen is stretched and the mortar is applied to a thickness of 25 millimetres, as described above. Inside this outer hull a second hull is built, distant 15 centimetres from the first. Small concrete joists, 5 centimetres square and 15 centimetres long, are placed at right angles to the outer hull at the points of intersection of the reinforcing bars, the rich mortar having been omitted over these points in forming the outer hull. Over the joists is stretched a rather fine, 3-millimetre wire screen, which receives first a layer of rich and then a layer of ordinary mortar. While the latter is still soft, a screen similar to that used in the outer hull is applied to it; by adding the two layers of mortar, an inner hull similar to the first is obtained. Five transversal partitions divide the interior of the barge into six compartments. There is no deck, properly speaking, but only a sort of foot way, 80 centimetres wide, around the edge of the boat leaving three large hatchways in the centre. The stem and stern posts are built out to a section of 15 by 30 centimetres. They are covered on the outside with a steel plate 10 millimetres thick, which extends below the water line.

## GAS POWER IN GERMANY.

ITS EFFECTS ON THE TENDENCIES AND DEVELOPMENT OF THE NATIONAL INDUSTRY.

*F. E. Junge—The Iron Trade Review.*

THE possibilities of the gas power plant as a means of fuel conservation, so admirably reviewed by Dr. Charles E. Lucke in our April number, are strikingly illustrated by a system of power development which has been widely adopted in Germany during recent years, principally as a result of the advent of the large gas engine and an intelligent appreciation of the importance of the rational utilization of coals. This is the generation of electrical energy in large central stations located at coal mines or other cheap sources of fuel supply, and the provision of extensive systems of power exchange all over industrial and rural districts. The system has been developed to such an extent as to produce certain well marked effects on the tendencies and progress of the national industry, a few of which are summarized by Dr. F. E. Junge in *The Iron Trade Review* for February 25.

"The 'electric canalization,' as the Germans call it, is now the favorite mode of operation in Germany, where conditions are especially favorable to the scheme on account of the fact that all sources, exchanges and needs are so much closer to each other than they are in countries of extensive cultivation like America. It must be remembered that the total area of Germany is only four-fifths the area of Texas, with comparatively meager resources and a population of 63,000,000 of active people to support. The aim of the system of power exchange is, of course, an economic one: to save in initial and operating costs of plants and to balance the stability of output by a corresponding provision for consumption: in other words, to obtain a constant high load factor for the combination of works, which are located in a certain commercial distribution sphere relatively to each other, and to provide for a common and ample source of energy in cases of emergency. The elimination of special power generating units and costly reserves at minor places of consumption, and the maintenance of a constant high load factor at all central stations are the cause of great savings in fixed charges and operating cost. As for the latter item it is well to remember that in some gas power plants an increase of the load factor from 25 to 50 per cent. will halve the cost of power. These are some of the technical considerations.

"Other reasons for the fast spreading of energy distribution from mines and furnaces are to be found in the fact that, in a country where the railroads are owned by the government, the coal mine owners have to pay considerable sums to the state for transportation charges. In exchange they receive from the government a not over quick but impartial service, secret rebates are unknown and the smallest dealer is given practically the same facilities as the most influential trust. But notwithstanding all that, the aim of the coal owners, in Germany as elsewhere, is to get tonnage, or, in other words, to get the maximum immediate profit from the available resources. Therfore they have sought for other trade outlets for their goods and especially for such as will liberate them from the burden of government charges and control. Now technical progress has made it feasible for them to gasify all the lower grades of coal, those containing much moisture and ash and even coking coal, right at the mouth of the pit, and to transmit the products of higher order, as electric current, gas, coke and by-products, to the markets. These markets are offered in neighboring cities, where heat, light and power are required, and by railroads and canals.

"This mode of transforming raw coal into products of a higher order and transmitting these by wire, cable or pipe means for the government a loss of income from coal freights, with no substitute to fill the fiscal purse. It is natural, therefore, that a state monopoly for the production and distribution of electricity should have been proposed. However, it is too radical a proposition to be realized at once, and so a tax on electricity and gas was suggested instead. Now there is a hue and cry all over Germany that a new burden is laid on the national industries in addition to those which territorial adversities and limitations inflict upon it.

"With the spirit of military discipline permeating the whole nation, however, we believe it proper that some means of control should be devised to check the over-zealous efforts of private monopoly powers, as soon as their business methods become dangerous to the commonwealth. This is the case with overland centrals, who become the suppliers of heat, light and power to large and densely populated districts of the country and are placed in a position to direct the activities of a thousand depending industries, communities and individuals, according to their notion.

"Now the ordinary means of controling the price policy of private corporations, which the German government has had at its disposal so far, consisted either of adjusting the prices of identical goods produced by the state, as is done with coal, or raising or lowering the tariff, as the case may be, or to regulate freight rates, as has been done

with very good effects in a number of industries. Obviously these three means would not work with a combine, which generates and distributes, besides other products, electric current on a large scale. To give an idea of the size of these overland centrals we may mention the Rhenish Westfalian Electric Central Station, or rather the 'Verbandeselektrizitätswerk,' with a generating capacity of 23,000 kilowatts in 1907. Reports from the largest of the combined plants show for 1908 a distributing net of 43,400 kilowatts, 1,357 kilometres long. In the lower Rhenish coal district an overland central will supply the counties of Cleve, Geldern, Kempen, Mors and Rees. The territory supplied with current covers 483,000 acres, with 300,000 inhabitants, 11 large and 127 small cities and 490 villages. It is obvious that a dependence of such a vast number of public and private interests upon the benevolence of an electricity trust is dangerous. I do not share the belief that a tax on electricity would harm the development of industry.

"In Germany we have to console ourselves with the words of Lord Bacon: 'Prosperity is the blessing of the old testament; adversity is the blessing of the new, which carrieth the greater benedictions.' Especially is this so in our iron industry. Generally speaking, the vast and continuously increasing demand for iron and steel must be accompanied, inevitably, (1) by the growing difficulty of finding suitable ores in sufficient quantities and qualities, and at convenient distance from the fuel supply; (2) by an increase in the weight of coke that must be charged at the furnaces together with the ore for smelting the latter; (3) by a rise in the cost of production for half finished and finished goods, owing to the higher prices that must be paid for ores, fuels and labor."

In the future, even more than in the past, the productive efficiency of iron and steel works, especially of those which own no coal mines and have no control of transportation facilities, will depend upon the efficiency of the utilization of waste gases and low-grade fuels for power production, in the place of the expensive boiler and furnace coals now purchased. "The only means so far devised for obtaining proper utilization consists in the application of large gas engines in the central station, where the weakness of the gas engine as a prime mover can be most effectively counteracted and its good points fully secured. This modern mode of operation enables one, owing to the economic generation and transmission of electric current, both to employ electric drives all over the works, thereby securing maximum economy of operation, and to distribute the remaining energy to neighboring industrial centers, cities, railways, waterways, etc., at a profit. In some sections of our country this combination of iron and steel works with overland central stations has proved very profitable to the stockholders of the concerns. As a fair average the addition of a gas engine-driven station to a combined plant pays about 20 per cent. interest on the capital invested. The principal condition for success is, of course, that markets for the disposal of current are not too far distant, else initial cost and transmission losses eat up the profits.

"The most unfavorable conditions for the iron industry obtain in the southwestern part of Germany and in Luxembourg. There coal and ore are not available within reasonable distance. The Minette ores contain no more than 28 to 30 per cent. iron and require considerable quantities of coke per ton of pig at the furnace. Coke must be shipped either from the Saar or from the Ruhr districts, and freight rates are high. The amount of coal which is used in the steel works of a combined plant averages about 300 to 400 kilograms, (one kilogram equals 2.2 pounds) per ton of finished goods. The amount of coke required in the furnace averages 1,000 kilograms per ton of pig, or 35 to 40 per cent. of the net cost of pig.

"When coal mines are attached to iron and steel works coal is used in various ways: (1) the inferior grades of coal, mine culm, waste, etc., are gasified in producers especially equipped for the purpose, preferably recovering from the material some of the by-products;

(2) fat coal is coked in by-product coke ovens, with the recovery of tar, benzol and ammonia; (3) dust coal and other material of small size, which it would be unprofitable to transport, is either used for direct grate firing, or it is gasified in producers, or it is transformed to briquettes, and the surplus of these marketed through the coal syndicate.

"The most efficient of all processes of coal utilization is undoubtedly the coking of it in by-product coke ovens, and the subsequent use of the coke in the blast furnace. One ton of coking coal which is thus charged to the oven, and which may contain five per cent. ash, 20 per cent. volatile matter and 75 per cent. carbon, will produce the following values: 200 kilograms of volatile matter give 2.5 kilograms of ammonia or 9.7 kilograms of sulphate of ammonia; further 25 kilograms of tar, 4.5 kilograms of benzol and 135 effective horse power developed in coke-oven gas engines. The 750 kilograms of carbon charged to the furnace together with the ore, will yield 800 kilograms of pig iron, 1,000 to 1,500 kilograms of slag, used for making cement and bricks, and 600 horsepower developed in blast furnace gas engines.

"As a matter of experience the savings resulting from a reduction of the fuel bill by the adoption of gas power vary from 50 cents to $1.25 per ton of pig made, according to the locality and extent of application. The income from surplus energy and from by-products will naturally be higher in a concentrated country like Germany, with highly developed chemical industries, than it could be in the United States under present conditions. In the case of steel works gasifying all their coal (200 tons daily) in producers, and recovering only one by-product, sulphate of ammonia, from the gas before using it in the steel furnaces, the saving is reported to amount to $400 per diem, thus reducing the self cost of raw steel by from 50 to 75 cents per ton. Of course, all this refers to commodity prices as we have them in Germany. Coal is much more costly than it is in America, while labor costs about one-third, taking the average of twelve trades."

## THE APPLICATION OF MOTORS TO MACHINE TOOLS.

A REVIEW OF METHODS OF DETERMINING POWER REQUIREMENTS, THE CHOICE OF MOTORS AND THE SELECTION OF THE DRIVING SYSTEM.

*H. W. Peck—The Electric Journal.*

IN two recent numbers of this magazine, certain features of the subject of electric driving in industrial and manufacturing establishments have been discussed at some length. The merits and advantages of the individual drive were comprehensively outlined by Mr. Howard S. Knowlton in the December, 1908, special number; and the following month a review in these columns gave the main points of an extended discussion of the choice of motors for various services and the available methods of speed control. We return to the subject to present the following abstract of an interesting paper by Mr. H. W. Peck in *The Electric Journal* for February, dealing particularly with the methods of determining power requirements.

"The method of determining the motive power equipment of electric railroads is fairly well known. The route is mapped, showing all grades, curves and stations. A tentative schedule is laid out and calculations are made to determine the extent and duration of power demands upon the motors. Certain severe demands are doubtless found which, if insisted upon, require very large motors as compared with the average demand. The schedule is, however, modified to materially reduce some demands and to increase others. After most careful analysis a schedule and a type of motor are selected which will work together in harmony to accomplish a satisfactory trip with a motive power equipment of moderate size and with a fairly uniform demand upon its staying powers. To accomplish this harmonious result the

railway man modifies his first schedule in such particulars as are found to demand poor design of the motors and the motor designer selects such a design of motor and equipment as will most nearly approximate a uniform loading when working according to the schedule.

"The method of working out the motor equipment of an industrial establishment is not dissimilar to that of a railroad. In the first place the superintendent selects his machines and arranges them in his building as will best facilitate the handling of the material, afford the best light, occasion the least danger from accident, and to the greatest degree obtain economy of production. He states the general features of operation of each machine under different working conditions, the time it is run, the kind of material it handles, its relation to other machines, etc. This arrangement is then submitted to the engineer for analysis and criticism.

"First the engineer considers the power requirements of each machine individually. Rotative power is the product of torque and speed, work the product of power and time. Speed-torque time characteristics must be determined for each machine. This requires tests and calculations in addition to the statements of the superintendent as to the hours, use and other conditions of operation. This data may be secured by some one of several methods or possibly checked by two of them. Sometimes the manufacturer will furnish guaranteed performance curves or statements. This has been the practice of some manufacturers of electrical apparatus for many years and is being required more of other manufacturers. Furthermore, the facility of making accurate tests by means of electric motive power and electric instruments has brought the matter of testing within the means of the smallest manufacturers. Usually the central station company is glad to co-operate in making tests on apparatus which, when sold, will require electric energy to operate, the manifestly wise course in a broad business policy. Centrifugal pumps and blowers are notable examples of machines, the performance of which will always be guaranteed by the manufacturers. Frequently the size of the motor will be recommended by the manufacturer, but this should not be relied upon. Some recommend a small motor to indicate an efficient machine and trust that the user will not overload it; others recommend a motor of excessive size on the theory that the user will always overload his machine and it is better to have too much rather than too little power. Either practice is manifestly bad. With the earnest co-operation of the motor manufacturers, the data and recommendation of the machine manufacturers becoming much more reliable.

"A second method is sometimes used when power is distributed through shafting from one steam engine or electric motor. This is to measure by means of indicator cards or meters as the power may require, the total input under more or less known varying conditions. Where the friction is apt to be as great or greater than the load, the power determination is only an approximation likely to be misleading, and if no better determination can then be made to aid in the motor selection, a careful check should be made as soon as a better method is available. By replacing the machine by a prony brake and measuring the effective power output when the power input is the same as with the machine on, the varying friction losses can be eliminated and the real power output determined.

"A third method of determining the performance is to measure the torque directly by means of a simple dynamometer. This method is scientific and is often of great value. It is used to obtain starting torque, which is difficult to obtain otherwise, and the running torque of slow-speed machines and others whose torque is constant and whose work is proportional to the speed. Examples of machines which can be advantageously tested in this way are elevators, whose starting torque exceeds the running torque by approximately the ratio of the static to the running friction of the gearing, and tumblers whose low speed makes it possible to make complete tests. In the case of elevators this must be sup-

plemented by calculations when a certain specified rate of acceleration must be effected. Reciprocating machines with heavy parts alternately accelerating and decelerating cannot be tested practically by this method. A transmission dynamometer can be used in a wide variety of machines.

"A fourth method is by calculations from the general data concerning the work to be done by the machine, in some cases a method of very great value. A fifth method is to drive the machine by means of an electric motor, and from suitable meters connected in the line to determine the power input of the motor under all working conditions. Then from the known performance of the motor or by making further tests on the motor with a prony brake, the exact power required by the machine may be easily calculated. This is in most cases an ideal method and is often used even for machines normally driven from a line shaft or a steam engine by running temporary wires and setting up a motor to drive the machine for the test. In this way an entire establishment, driven by one motor through long shafting, can be accurately studied for individual motor application. Generally two test motors can be selected with sufficient range for accurate tests of the entire plant.

"By means of a graphic recording meter running at a high rate of speed, an exact record of the instantaneous power required throughout the cycle of operation of any machine, such as a shaper or group of machines can be obtained. This affords a basis of study properly to equip each machine and also to run an entire shop most economically. It shows the comparative power required by an old and new style machine; for instance, whether a machine is over-counterbalanced, whether the operatives are slow to begin work and quick to shut down their machines. Speed indicators, stroke counters, graphic stroke indicators, dynamometers, engine indicators, prony brakes, indicating, integrating and graphic recording electric meters; these are some of the more important tools used. It is important, especially in old plants which are being modernized, to examine each machine with the idea of replacing it if possible with a new machine of enough greater efficiency to warrant the investment and with the idea of correcting mistakes in operation which may have crept into practice insidiously and remained unnoticed.

"Of prime importance is the matter of speed variation, for upon this requirement, more than any other, depends the choice between the direct and alternating-current systems, if both sources of power are available from the central station. Direct-current motors can be obtained with a range of speed of as much as one to six, capable of operation at full-load and high efficiency at any speed within this range. Two or three-speed alternating-current motors may be obtained in the larger sizes with good efficiency, but as a rule, variable speed alternating-current motors are of such low efficiency at the slow speeds that they cannot be used economically for continuous service at the slow speeds. If a large proportion of variable speed motors is required, then the direct-current system is desirable. If few or none of the machines require variable speed alternating-current is preferable, chiefly on account of the simple and rugged construction of the motors. There are either no moving contacts or else slip rings only with low potential across them. The only wearing parts are the two shaft bearings; the only attention required is the oiling of the bearings and the general cleaning of the machine. Alternating-current motors have, in general, more nearly constant speed than direct-current motors. They are capable of being loaded momentarily to a standstill without injury, have a maximum torque of two and one-half to three times full-load torque, and can be started in the smaller sizes without a rheostat.

General rules for the choice of motors may be summarized as follows: for machines which start with light load and run at moderate and constant speed with fairly uniform load (lathes, milling machines, grinders, tumblers, etc.) shunt-wound d. c., or squirrel cage a. c. motors are best suited; for similar constant and uniform service but high speeds, a spe-

cial d. c. motor designed to give good commutation with a weak field; for high starting torque with constant speed operation, a compound-wound d. c. motor or an a. c. motor with wound secondary should be used. Series-wound d. c. motors and induction motors with wound rotors, in which the speed is inversely proportional to the load, are largely used for crane and hoisting work. Synchronous motors are seldom used because of their cost and difficulty of control.

In applying motors to machine tools a thorough understanding of the principles of mechanics and familiarity with mechanisms is essential to obtaining the best results. To illustrate this point the importance of the fly wheel for use in equalizing loads on machines with intermittent sudden demands may be mentioned. "The correct selection of the best method of transmitting the power from the motor shaft to the machine, whether by coupling, gears, chain or belt, requires not only a knowledge of possible arrangements but acquaintance with their comparative advantages and disadvantages, adaptability and limitations, and above all the essential requirements for successful operation."

Individual drive should be chosen "when (1) the cost of installation is less than for group drive; (2) when the saving in operating cost of the individual drive is more than enough to pay the added fixed charges of this form; (3) when the convenience of operation is worth the additional cost which may be involved. The latter is a hard thing to capitalize. It includes such features as cleanliness, more light and less shadows, less noise, more uniform operation, quick and easy control of speed, less danger from moving belts or accidental starting, reliability, flexibility under present or unforeseen conditions, location and relocation of machines without thought of power supply, simplicity of remote control and automatic operation, freedom from annoyance and delay due to loose and broken belts, ability to support the motor from the floor, side wall or ceiling, the two latter methods making available the floor space otherwise occupied by motors or vertical belts. Some manufacturers have been able to determine its value partially by the increased production of their factories which has amounted to from 10 to 25 per cent with equal or less power cost."

## CONCRETE IN MINE SUPPORT.

A SUMMARY OF THE SITUATIONS IN WHICH CONCRETE MAY REPLACE TIMBER.

*W. R. Crane—Mining and Scientific Press.*

THE growing scarcity of suitable timber for mine support in many parts of the United States has made the substitution of some other material an imperative necessity. Abroad, stone and brick have been used to some extent, but they have not found favor in American practice, primarily because of the high cost of transportation but also because neither material is impervious to water. Of all possible materials, concrete seems to be best adapted as a substitute for timber. It can be placed more readily, and with less skilled labor, than either brick or stone; hence its first cost is likely to be considerably less. It takes several times as long to set concrete as to place timbers, and the first cost is from 25 to 45 per cent higher, depending largely on the shape of the construction; but compared with timber concrete has great strength and when once constructed is practically indestructible. It is rapidly growing in favor for a large number of purposes in mining work, of which the following abstract of an article by Mr. W. R. Crane in the *Mining and Scientific Press* for February 27 gives a brief summary.

One of the principal uses of concrete so far has been for lining shafts. When brick or stone is used for this purpose a circular or elliptical form has to be adopted for the shaft. Though several rectangular shaft linings have been constructed of concrete the elliptical or circular shape is to be preferred, especially when the concrete is placed in the form

of blocks. The curved form is not economical of space but, on account of its superior strength, only about half the thickness of lining required in rectangular shafts is necessary, and the excavation is actually reduced, while the cost of the concrete lining is practically halved.

Numerous striking examples of concrete linings for steeply inclined shafts are to be found in the Lake Superior copper region. The shafts are inclined from 35 to 80 degrees from the horizontal, and, in the larger mines, have two hoisting compartments and a man-way. Usually the upper part passes through 40 to 80 feet of water-bearing glacial drift. Arched linings are built through this stratum, which are carefully connected with bed rock, drainage holes being provided through which the excess of water can escape. Rectangular linings have been placed in four vertical shafts recently sunk at Lackawanna collieries in the vicinity of Scranton, Pa., passing through 60 to 75 feet of soft material before encountering bed rock. An interesting elliptical shaft, 23 feet by 15 feet inside measurement, at Bridgeport, Pa., has 81 feet of concrete lining. This was put down as a sinking lining or drop shaft. Concrete was placed in about 30 feet of forms built on a heavy timber shoe with an angle-iron cutting edge, after the latter had been levelled in the initial excavation. After ten days the outside members of the forms were removed and the lining was lowered to bed rock in the usual manner in sinking with a drop shaft. This method has been employed in sinking through quick-sand at Biwabik, on the Mesabi range, the reinforced-concrete lining being built up in 8-foot sections as the excavation proceeded. Concrete has also been employed for re-lining timbered workings, notably in the Manville shaft, near Scranton.

In tunnel work, two or more lines of track necessitate an arched roof: the lining of single-track tunnels may be rectangular or oval. In double-track tunnels the compartments are usually separated by longitudinal partitions of concrete, plain or reinforced. A very successful application of concrete arches and columns for tunnel supports has been made in the mines of the Philadelphia and Reading Coal and Iron Co. Concrete arches, 18 inches square, replace 14 to 16 inch posts and caps, lagged with 4 to 6 inch round timber, and spaced 5 feet center to center. Old rails and old wire rope are used for reinforcement. The cost approximates $22 per arch.

Large concrete columns are successfully used for supporting the roof at points where it is important that no settlement should take place, such as the intersection of roadways, where wooden rock-filled cribs or timber supports would be unsatisfactory. Concrete is being widely employed in both coal and metal mines for supporting and lining shaft and pump stations, and special rooms, such as underground offices, hospitals, lamp rooms and stables, are now being built of this material.

In the Pennsylvania coal fields the preservative treatment of mine timber has been undertaken on a large scale by a number of the leading companies. It is interesting to note, however, that the company which has experimented most extensively with concrete props, the Reading, proposes to build a plant at the North Franklin colliery, where such props will be manufactured for distribution to neighboring properties.

The possible applications of concrete peculiar to coal mining are very numerous. In Europe it is widely employed for the support of weak roofs where thick coal seams are worked in benches. Each bench, when the one above is excavated, is covered with a bed of concrete 8 to 10 inches thick, placed in sections transversely to the working face. Upon this bed of concrete is placed the filling with which the excavation is stowed on the removal of the coal, and by it the filling is supported while the next bench is being excavated. The concrete also serves as a support for the tracks. Concrete is being used in the construction of the overcasts of airways; in some places it is replacing wood and stone. The problem of ensuring brattices and air stoppings against danger from explosions has been solved by the employment of concrete; its use for this purpose is now common practice.

Reinforced concrete has been used in the construction of very heavy bulkheads in the Ontario adit of the Daly-West mine. One of the first uses to which it was put was that of building foundations for heavy machinery, both on the surface and underground. Intercepting ditch construction of concrete is now quite commonly used. An important application is in the support of mine tracks. Large longitudinal stringers are built, upon which the rails are mounted and to which they are securely bolted, a type of construction used in a number of the Lake Superior copper mines. A further extension in the use of concrete in and about mines is its employment in the construction of powder magazines.

Mr. Crane illustrates a number of the structures referred to in his paper and concludes with a short bibliography of the subject of concrete in mines.

## THE EFFECT OF TITANIUM ON STEEL.

RESULTS OF THE USE OF FERRO-TITANIUM IN THE MANUFACTURE OF BESSEMER, OPEN-HEARTH AND CRUCIBLE STEELS, AND OF CHILLED CASTINGS.

*Charles V. Slocum—Electrochemical and Metallurgical Industry.*

WE have already given in these columns, in THE ENGINEERING MAGAZINE for August, 1908, a few data on the effect of titanium on cast iron. The use of ferro-titanium in the foundry has considerably antedated, in the United States, its application in steel making; but within the past two years a number of important researches on the effect of titanium on Bessemer, open-hearth and crucible steels have been made, with highly interesting and significant results. A summary of the more important information now available, of peculiar interest because of its indication of the possibility of effecting substantial improvement in the quality of steel rails, is given by Mr. Charles V. Slocum in the *Electrochemical and Metallurgical Industry* for March, from which the following abstract has been prepared.

"With the aid of titanium it is possible to make better rails from Bessemer converter steel than is possible without its aid from open-hearth steel. With the aid of titanium it is possible to eliminate blow-holes. It is further possible to remove the brittleness and increase the durability of chilled-iron car wheels; further, to improve nickel steel, chrome and nickel steel, etc." The titanium is introduced into the steel in the form of the alloy ferro-titanium, sold under the trade name of "titanium alloy." It contains from 10 to 15 per cent. titanium, 5 to 7 per cent. carbon, less than 0.5 per cent. impurities, and the remainder, over 80 per cent., iron.

"Ferro-titanium was used for the first time in a heat of Bessemer steel in the United States at the works of the Maryland Steel Co. in November, 1907. The steel made at this first trial showed so much improvement over ordinary Bessemer that trials in several heats were made on Dec. 16, 1907. These trials developed several remarkable features, probably the most important of which was the unprecedented increase in the quantity of slag removed from the steel. The treated metal invariably lay 'dead' in the ingot molds. The steel was absolutely free from blow holes. The titanium-treated ingots were noticeably hotter than the untreated ones. An examination of the record from the pyrometer gage for the day's work showed an increase of not less than 15 degrees C. in the heat of the treated metal at a given point in excess of that of the untreated metal at the same point, while passing through the rolls. The titanium alloy was added in the ladle after the blow, and after the manganese, the former being simply shoveled in cold by a laborer while the steel was flowing into the ladle." Since these trials the Maryland Steel Co. has used titanium in many heats with unvarying success. Experiments have been made also by the Carnegie Steel Co., the Cambria Steel Co., and the Lackawanna Steel Co., with eminently satisfactory results.

"Rails treated with titanium alloy and made by the Maryland Steel Co. have been in service for several months on Kesslers Curve on the Cumberland Division of the Baltimore & Ohio Railroad, where the traffic and the grade are both very heavy. Diagrams of these rails have been taken at intervals of two to three weeks, together with diagrams of the plain Bessemer rails put in at the same time and place. The greater durability of the titanium rail is so marked as to be fairly startling. The lower plain rails, although of best quality Bessemer, have flattened or 'flowed' considerably, while at this writing the titanium rails have not 'flowed' at all. The upper plain rails are cut down practically the full depth of the flange of the wheels, while the upper titanium rails are cut less than half as much.

"Titanium alloy has been used by many open-hearth steel works with unvarying improvement to the product. The general characteristics are freedom from blow holes, increase of elastic limit, increased reduction of area, etc. The increase in quantity of slag removed or 'lifted' by the alloy is almost as remarkable in open-hearth steel as in the Bessemer product. The titanium itself passes off with the slag which it removes, unless unusual quantities of the alloy be added, when the excess above the quantity necessary to remove the impurities remains in the steel.

"Rolls made from open-hearth steel treated with titanium alloy are closer grained, absolutely free from blow holes or pin holes, are more durable than any other rolls, and are easily machined. Open-hearth castings from metal treated with the alloy are more blue in color, are free from blow holes, are free from brittleness, are easily machined, and heat less under the tool, hence may be machined more rapidly than other steels of the same carbon content. With respect to the removal of blow holes, the well-known high affinity of titanium for oxygen and nitrogen is, of course, of greatest importance. Any oxide of iron is perfectly removed by titanium.

"The reaction due to the titanium addition is always accompanied by an evolution of heat which may result in an increase of temperature of from 30 degrees to 50 degrees C. In an experiment of Messrs. FitzGerald and Bennie the rise in temperature, according to the Féry radiation pyrometer used, was 30 degrees C., although the titanium caused the formation of slag which cut off the radiation somewhat from the pyrometer. They state that their tests indicate a distinct rise in temperature to be obtained 'even with so small an addition as 0.5 per cent. of the 10 per cent. titanium alloy.'

"In view of these facts the amount of ferro-silicon which would be used for the same purpose should be reduced, when ferro-titanium is employed. It is suggested that the silicon be reduced gradually from time to time until no further improvement is noted. If dirt specks are found in the surface or 'skin' of the steel the ferro-manganese should be slightly increased by adding, say, 10 pounds for each 100 pounds of manganese used, and the ferro-silicon should be cut out.

"As said before, the use of titanium improves Bessemer steel so that it becomes better than present open-hearth steel. It brings open-hearth steel nearer to crucible steel quality. That with the aid of titanium it is possible to improve even electrically refined steel of crucible steel quality is indicated by the following tests quoted from Mr. F. A. J. FitzGerald's recent paper before the American Electrochemical Society. The tests were made from bars 1 inch square, hammered from 6 by 6 bottom cast ingots. The elongation was determined in a length of 2 inches:

| Heat No. | Tensile strength | Elastic limit | Elong. per ct. | Red. per ct. |
|---|---|---|---|---|
| 9 | 57,000 | 34,000 | 33 | 58 |
| 27 | 77,000 | 45,000 | 28 | 56 |

The steel of heat No. 27 was treated with 0.1 per cent. of titanium.

"The analyses given by Mr. FitzGerald are the following for the two heats mentioned above:

| Heat No. | 9 | 27 |
|---|---|---|
| Carbon | 0.10 | 0.22 |
| Manganese | 0.75 | 0.94 |
| Phosphorus | 0.015 | 0.033 |
| Sulphur | 0.070 | 0.056 |
| Silicon | 0.02 | 0.03 |

A bar of steel 4 feet long, 1⅛ inches square made from this titanium steel (heat No. 27) was subjected to cold twisting test, seven complete turns or revolutions without a fracture.

"It has been found by experiment many times repeated that titanium alloy increases the strength of nickel and chrome-nickel steel. It is a well-known fact that when nickel is added to steel an important percentage of oxide of nickel is formed. Titanium alloy used afterward thoroughly deoxidizes the metal.

"The alloy also 'removes nitrogen in the proportion of about four parts titanium to one of nitrogen, a very important fact since neither chrome, nickel, molybdenum nor tungsten combines with nitrogen, so that none of these metals nor their ferros can be used for removing this gas to form with it a stable combination to pass into the slag.' (A. J. Rossi.) Hence the following statement of Prof. Le Chatellier, of Paris, is very pertinent: 'The treatment of all steels with ferro-titanium for the purpose of the purification of the metal is strongly recommended. The presence of nitrogen to the extent of 0.02 to 0.045 or 0.035 in certain steels is enough to cause the metal to break asunder, destroying all elongation and reduction of area.'

"To sum up, the effect of titanium alloy in steel is to remove the oxides and nitrides, to increase the fluidity and temperature of the metal and to increase the quantity of slag which it not only removes, but with which the titanium itself passes off. The resulting product is stronger, more durable and more easily machined. The casting heats less under the tool and gives greater resistance to shock, strain or wear. Titanium alloy has been used with success in gears, pinions, automobile cylinders, dies and die blocks, chilled rolls, car wheels, etc."

According to tests by Hokanson the crushing strength of chilled iron is increased nearly 100 per cent. by the use of 1 per cent. of titanium alloy. Stoughton places the increase in strength in gray iron castings at 20 to 40 per cent. Chilled iron treated by titanium is harder than the untreated metal although the chill is reduced by the alloy. The value of titanium in iron is demonstrated by some recent tests at the car-wheel foundry of the Norfolk and Western Railway Company. A strong car-wheel iron treated with one per cent. titanium alloy in the cupola gave 24.4 per cent. more deflection than the plain metal, an indication that the alloy removes brittleness and makes car-wheel iron more like wrought iron.

## THE DETINNING INDUSTRY.

A REVIEW OF THE ELECTROLYTIC AND CHLORINE PROCESSES AND THE EXTENT OF THE INDUSTRY.

*The Iron and Coal Trades Review.*

THE treatment of tin scrap for the recovery of tin is one of the many industries which owe their existence directly to the advent of electrical-energy generation and distribution on a commercial scale. As early as 1876 Keith recommended treatment by electrolysis in an alkaline solution, and in 1882 the foundations of the electrolytic detinning industry were laid by Goldschmidt, who used tin scrap as anode and iron plates as cathode in an artificially heated solution of caustic soda. The later and more successful chlorine process depends upon electrical energy only indirectly. This branch of the detinning industry is the result of the availability of cheap electrolytic chlorine and the possibility of liquefying it. Patents covering chlorine processes have been granted at intervals since 1854 but the use of chlorine on a commercial scale has been obliged to wait upon the development of electro-chemical science. A brief review of the present state of the detinning industry is given in *The Iron and Coal Trades Review* for March 19, of which the following is an abstract.

The reaction in the electrolytic process may be described simply as follows:

"The electric current decomposes the water and gives oxygen at the anode, forming tin oxide which dissolves in the excess of caustic soda to form sodium stannate, while hydrogen is developed at the cathode and at once precipitates the tin on the cathode from the solution." The presence of free caustic soda is, therefore, a fundamental requirement. But caustic soda attracts the carbon dioxide from the air, and, further, on account of the great difference in size, more tin is dissolved from the anode than is deposited on the cathode. The free caustic soda has therefore a tendency to disappear and the solution then becomes ineffective. One of the main difficulties in the electrolytic process is to maintain continually a small excess of free caustic soda. If this excess becomes too small, the detinning is only imperfect and the iron is left in a condition which unfits it for use in the open hearth furnace.

The tin scrap is always placed in a basket connected to the positive pole. The high labor expense of the electrolytic process is due largely to the necessity of using only moderate charges; otherwise the tin scrap in the centre would not be detinned. The scrap cannot be used in the compressed form, since the electrolyte must have access to all surfaces, hence the usual charge per basket is only 10 to 20 kilogrammes.

The removal of the tin from the sheet iron so perfectly that the latter can be sold to open hearth plants can be effected only by very careful working and by giving continual attention to the right composition of the electrolyte. Even with very careful working 0.1 to 0.2 per cent. of tin will remain on the iron. In ordinary practice 0.3 to 0.5 per cent. is left.

The tin is obtained from the cathode in a spongy mass which is remelted to get it into a saleable form. The solid tin obtained is 97 to 98 per cent. pure. Besides the necessity of careful attendance and of using small charges, the electrolytic process has the drawback that a considerable amount of tin is lost in a portion of the electrolyte rich in tin, which adheres to the surface of the detinned iron when the latter is removed from the cells.

The reaction on which the chlorine process is based is very simple. If dry chlorine gas is passed over tin scrap, the chlorine does not attack the iron but combines with the tin to form anhydrous tin tetrachloride, a heavy fuming liquid, which drops off. Many difficulties were encountered, however, in applying the reaction to a commercial process, even after cheap chlorine was available. After treatment with chlorine it is absolutely necessary to remove from the scrap a film of a very obnoxious liquid which has a very bad effect on the eyes and noses of the workmen. It is impossible to use water for this purpose since a solution of the tetrachloride attacks the iron so that both become useless for commercial applications. Even if the anhydrous tin tetrachloride is removed, the iron will quickly rust so as not to have any commercial value.

A partial solution of this difficulty was made by Lambotte in the early eighties. He used a shaft furnace through which the scrap was carried downward from above, while the chlorine gas diluted with air was introduced at the bottom. The air carried the fumes of the resulting tin tetrachloride over into a condensing apparatus and the bundles of detinned scrap were removed from the bottom of the furnace. Even if all moisture was carefully avoided, however, the iron scrap was exceedingly liable to rust very rapidly. The reason was found in the fact that chlorine is not absolutely without any attack on the iron but leaves on its surface a very thin invisible film of anhydrous ferric chloride. Under the action of the moisture in the air the ferric chloride is reduced to ferrous chloride, which again attracts oxygen and water from the air, forming oxychloride; this is reduced by the iron, forming rust. Only when this fact was found out was the corrosion of the iron prevented, by removing the ferric chloride by a washing process.

After all organic substances and moisture, or anything which can form moisture, have been removed from the tin scrap, the latter is compressed into

bundles (in which form the iron is later sold to the open-hearth steel works) and placed in cylinders, which are then closed. Chlorine gas is then introduced. The reaction betwen chlorine and tin develops considerable heat; as it is important to prevent an undue rise of temperature, artificial cooling must be provided. To detin the scrap completely it is necessary to use the chlorine at a pressure of several atmospheres, so that it enters all crevices. The formation of tin tetrachloride causes a drop in pressure which continues as long as detinning takes place. When the pressure remains constant for any length of time, it is a sure indication that the process is complete. The chlorine and tetrachloride are removed, and the scrap bundles are carefully washed, preparatory to delivery to steel works.

The chief advantage of the chlorine process is that there is very little expense for attendance, since the scrap is passed through the process in large bundles and the process is completed in a single operation. The iron is detinned more completely than by the electrolytic process and no tin is lost in washing. The tin tetrachloride is a valuable product for its use in silk mills.

With the growth of the detinning industry the demand for the scrap from tin-can factories became much greater than the supply. Attention was turned therefore to the development of processes for detinning the enormous supply of old, used tin cans. The great difficulty was the removal of impurities from the cans, the remains of food, paper labels, solder containing lead, and the thin rubber rings placed in the folds. As at present practiced the process is as follows: the cans are first compressed and are then passed through rolls with a large number of cutting points; any adhering fat, lacquer, etc., is then removed by washing in caustic soda solution; after the cans have been carefully washed with water, the solder and rubber are driven off by heating in a furnace. The cans are then ready for treatment by the chlorine process.

In Germany about 75,000 tons of scrap are treated annually, in other European countries, about 25,000 tons, and in the United States, about 60,000, making a total for the world of 160,000 tons of scrap. The yield of tin is from 3,000 to 3,500 tons yearly, or about 3½ per cent. of the world's output of tin. The weight of the detinned iron is practically the same as that of the scrap. Two-thirds of the industry in Germany is in the hands of the Goldschmidt company at Essen. The Goldschmidt chlorine process is in use also as Lyons, France, and a plant with a capacity of 30,000 tons of scrap per year is soon to be erected near Carteret, N. J.

## THE RAILWAY THROUGH MONT BLANC.

A DISCUSSION OF ITS COST AND PROBABLE INFLUENCE ON INTERNATIONAL TRAFFIC ROUTES.

*Oesterreichische Eisenbahn-Zeitung.*

THE project of constructing a new international railway through the western Alps has now progressed to such a point that it remains only to obtain the necessary funds before the work of piercing Mont Blanc is actively begun. Both Italy and Switzerland will be materially benefited by this additional traffic route between northern and southern Europe, but the country most deeply concerned in the project is France. The piercing of the St. Gothard made possible direct railway communication between Germany and Switzerland, and Milan; but as the lines concerned are entirely outside France, this was a serious blow to French commerce, the resulting loss being estimated at 30 million francs per year. It was thought at the time that the opening of the Simplon line would make up for this loss and many proposals were made for connecting the French railway systems with the Simplon Railway. They were all bound to fail, however, as soon as the French recognized that the latter really forms a duplication

of the St. Gothard line and could be of little benefit in improving the condition of French commerce. Moreover, when the Lötschberg line is opened, there will be two parallel and nearly straight lines from the western part of upper Italy to the north, which will be very useful to Switzerland and Germany but of no use whatever to France. It is very necessary for French commerce that easy and direct access be had to the industrial district lying within the triangle Genoa-Milan-Turin, the latter of which is destined to become the center of the French trade; the existing railway connections between France and Italy will not suffice to carry the very heavy traffic expected in the near future. The Nizza-Ventimiglia and Nizza-Coni lines, now under construction, will not improve the situation materially, being too far to the south. On all counts the construction of a new railway through the western Alps is of paramount interest to the industry and commerce of France and it will soon be necessary to decide how it is to be carried out. A discussion of the project recently published in the *Oesterreichische Eisenbahn-Zeitung* and translated in the *Bulletin of the International Railway Congress* for February, of which a brief abstract follows, is, therefore, of very timely interest.

The longest part of the Alpine chain, not pierced by a tunnel, lies between the Mont Cenis and the Simplon lines. The distance is 186 miles. A straight line drawn on the map from Paris to Genoa will cut this gap about the middle and will touch Dijon, Geneva, Mont Blanc, Chivasso and Asti; thus it not only gives the shortest route between Paris and Genoa but also provides for important towns in between. Once such a railway is completed, then we shall have the shortest route between Paris and London, the two great commercial and business centers of Europe, on the one hand, and upper Italy, or more accurately, the triangle Turin-Milan-Genoa, on the other; and from the latter, the main routes start which go to the Tyrrhenian Sea, to Rome and Naples and the Adriatic. By far the greater part of these long and important routes are already equipped with railways. In order to fill the gap in the middle, all that is necessary is to build the section Lons le Saulnier, Saint Cloud, Geneva, Saint Gervais, Chamonix, Entrèves-Aosta and Chivasso-Asti. And this brings us to the most difficult part of the undertaking, the piercing of the Faucille and of Mont Blanc.

The Lons le Saulnier-Geneva section, via the Faucille, was formerly proposed by the City of Geneva as giving the best access to the Simplon. It has been included in the new project as it is the shortest connection with the existing section Annemasse-Bonneville-St. Gervais. The Faucille line has the advantage also of possessing the easiest technical conditions. There are few curves having a smaller radius than 1,650 feet; the greatest elevation the whole way does not exceed 1,834 feet, as compared with 2,315 feet in the Simplon, 3,789 feet in the St. Gothard, and 4,245 feet in the Mont Cenis; and the steepest gradients do not exceed 10 per thousand, as compared with 18 to 25 per thousand over 12 miles in the Simplon, 26 to 27 per thousand over 68 miles in the St. Gothard, and 24 to 50 per thousand over 50 miles in the Mont Cenis. The cost of construction, however, will be very high. It is estimated that the 47 miles of railway will cost 115 million francs, as it is to have double track and three large tunnels will be required. Of this amount the Canton of Geneva has pledged 20 million francs and the Paris-Lyons-Mediterranean Railway Company 40 million, leaving 55 million francs to be supplied by the state.

The shortest way from Geneva to Italy passes through the mass of Mont Blanc, which is to be pierced by a tunnel; subsequent to this the line is to descend to the Piedmont by the Dora Baltea valley. The geological conditions and the topography are nowhere else so convenient for a tunnel as in the case of Mont Blanc. The mass consists of a very compact form of true granite and its shape is such that it appears impossible that any great difficulties will arise. As the tunnel will be more than 3,280 feet above sea level, the greatest difficulties, high temperatures and the irruption of large

masses of water, are not likely to occur. The ample water power in the Dora Baltea valley can be utilized for electric traction; this will make it possible to have rather steeper gradients, at a correspondingly lower cost of construction, without in any way impairing the efficiency of the line. The latest determinations, made in 1907, gave the length of the Mont Blanc tunnel as 8 miles, between an elevation of 3,445 feet at Chamonix and 4,223 feet at Entrèves. The steepest gradient in the tunnel will be 30 per thousand, and on the lines of access, 20 per thousand. The cost of a double-track tunnel, which will certainly be required, is estimated at 60 million francs. The cost of the sections from St. Gervais on the one side and from Aosta on the other will be 15 million francs each, making the comparatively small total of 90 million francs for the cost of a double-track Mont Blanc railway. This amount would have to be contributed by France and Italy in equal proportions. The total expenditure on the French side, therefore, for the Dijon-Mont Blanc connections will be 100 million francs. Extensions necessary on the Italian side will bring the cost to Italy up to 70 million francs.

The three tunnels on the Faucille line are to be, respectively, 4, 7.1, and 9.45 miles in length. Each of these can be attacked from both ends at once, and the piercing of the longest tunnel is estimated to take four years. The time required by the Mont Blanc tunnel is estimated at five years. Hence it is expected that the new railway through the Alps will be finished five years after the work is actually started.

If the Mont Blanc railway is built, the lengths of the various routes by which international traffic can be carried between Paris and Genoa will be: by the St. Gothard, 651 miles; Mont Cenis, 595 miles; Simplon, *via* Pontarlier, 571 miles; Simplon, *via* the Faucille, 598 miles; and Mont Blanc, 540 miles. Besides the advantage of distance, the advantage as regards curves and gradients is in favor of the latter route. It is expected that the Mont Blanc railway will attract a great deal of the important traffic to and from India. At present the bulk of it goes *via* Ostend and the St. Gothard. The route to Brindisi *via* Calais and Mont Blanc will, however, have a slight advantage in distance and a considerable advantage in grade over the Ostend - Bale - St. Gothard route; while the actual difference in distance will be only 5 miles, the former will be virtually 82 miles shorter. No doubt a large part of the passenger traffic from north-western Europe to the East will be attracted to the new route, but what France is more particularly considering is the more important goods traffic to Italy and the East, which at present it does not share.

The Mont Blanc railway may affect materially south Germany and Austria-Hungary also. At present the exchange of goods between western and eastern Europe, up to the Black Sea, has its main route along the valley of the Danube. It is now thought that this traffic could be deviated by the Simplon line to the south, by sending it to Switzerland, and through the valleys of the Po and the Save to Belgrade, so that in this way the important centers Bucharest, Constantinople and Odessa could be reached more quickly. This plan would be greatly facilitated by the building of the Mont Blanc line, as the detour through Pontarlier would then be eliminated, and the whole of the traffic from western Europe to the countries adjoining the Black Sea and to Servia could take the Mont Blanc route. The Simplon route has an advantage of distance amounting to 63 miles over the Strassburg-Budapest line and this would be increased by another 63 miles by the opening of the Mont Blanc railway. The result would be that Italy would then share in the Balkan traffic in which it now has no interest, Austria-Hungary would lose a great deal of the through traffic, and south Germany would entirely lose the through traffic. The alterations in international traffic routes which would be brought about by the Mont Blanc line would thus be greater than those which have resulted from the opening of the St. Gothard, of the Mont Cenis and of the Simplon lines.

# THE ENGINEERING INDEX

"THE KEYSTONE IN THE ARCH OF APPLIED SCIENCE."

The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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## CIVIL ENGINEERING

### BRIDGES.

**Arches.**

Experimental Verification of Arch Formulas. Malverd A. Howe. Describes experiments made to verify the results obtained by using the writer's summation formulas for the fixed arch as applied to ribs of reinforced concrete. Ills. 2500 w. R R Age Gaz—March 26, 1909. No. 3516.

See also Concrete and Reinforced Concrete, under BRIDGES.

**Bascule.**

A Novel Arrangement for a Rolling-Lift Bascule Bridge in Burma. Illustrated description of a bridge over the Ngawun River, giving 200 ft. clear channel. 800 w. Eng News—March 25, 1909. No. 3493.

Bascule Bridges Over the East Chicago Canal. Illustrates and describes bridges of the Rall patented type of bascule bridge, four of which are to be built for railways crossed. 2500 w. Eng News—March 18, 1909. No. 3244.

**Blackwell's Island.**

Nickel-Steel Eye-Bars for Blackwell's Island Bridge. William R. Webster. A summary of the preliminary experimental tests made, with tabulated results. 3000 w. Pro Am Soc of Civ Engrs—March, 1909. No. 3498 E.

*We supply copies of these articles. See page 319.*

**Cantilever.**

See Viaducts, under BRIDGES.

**Concrete.**

Short-Span Bridges in Philadelphia. Concrete and steel railroad and highway bridges recently built in the suburbs are illustrated and described. 1500 w. Eng Rec—March 13, 1909. No 3112.

The Stress Sheets and Some Construction Details of a 280-ft. Span Rubble Concrete Arch Bridge at Cleveland, Ohio. Illustrated description of general structural features of the Rocky River arch, with stress computations. 2000 w. Engng Con—March 10, 1909. No. 3093.

**Culverts.**

The Design of Culverts and Sewers. Abstract of a paper by Ernest McCullough, before the Ill. Soc. of Engrs. and Surv. A study of earlier structures and the theories of their design. 2500 w. Eng Rec—Feb. 27, 1909. No. 2851.

The Standard Reinforced Concrete Culvert Construction of the Iowa State Highway Commission. Illustrations and particulars of examples of concrete culverts and highway bridges. 1000 w. Engng-Con—March 3, 1909. No. 3028.

**Erection.**

Derrick Cars for Bridge Erection. Illustrated description of designs, described by J. H. Prior in a paper before the Western Society of Engineers. 2500 w. Eng Rec—March 6, 1909. No. 2973.

Handling Complete Bridge Spans. Illustrates and describes work on the Lehigh & New England in which the spans were assembled off the bridge, then brought into position over the old truss and hung from gallows frames. The old truss was then removed and the new truss lowered into position. 1200 w. R R Age Gaz—March 12, 1909. No. 3097.

**Floors.**

Reinforcing the Glens Falls Highway Bridge Floor. Illustrates and describes an ingenious system. 1500 w. Eng Rec—March 13, 1909. No. 3110.

**Foundations.**

Foundations for a Concrete Bridge. George A. McKay. Describes work in connection with the erection, by the D. L. & W. R. R., of a large bridge across the Delaware River. Ills. 2000 w. Harvard Eng Jour—Jan., 1909. No. 3194 D.

**Lift Bridges.**

Lift Bridges. An illustrated discussion of many types of movable bridges. 17500 w. Pro Engrs' Soc of W Penn—Feb., 1909. No. 3454 D.

See also Bascule, under BRIDGES.

**New York.**

Our Four Big Bridges. Montgomery Schuyler. A critical study of the aesthetic and scientific qualities of the East River bridges at New York City. 5500 w. Arch Rec—March, 1909. No. 2915 C.

**Reconstruction.**

The Widening of Blackfriars Bridge. An illustrated review of the methods for completing the superstructure. 1200 w. Engng—March 5, 1909. No. 3164 A.

**Reinforced Concrete.**

Comparative Construction and Maintenance Costs of Reinforced Concrete and Steel Bridges. E. P. Goodrich. Read before the Nat. Cement Users Assn. 6500 w. Engng-Con—March 17, 1909. No. 3235.

Concrete Bridges. Frank Barber. Discusses some of the concrete and reinforced concrete bridges and the reasons for their popularity. Ills. 2500 w. Can Engr—March 5, 1909. No. 3005.

A Reinforced Concrete Arched Rib—Fixed Ends. A. W. Miller. Drawings and explanation of methods of designing a proposed 12th street bridge, at Oakland, Cal. 5000 w. Cal Jour of Tech—Feb., 1909. No. 3502.

The Wyoming Avenue Arch Bridge at Philadelphia. Illustrated description of two concrete highway bridges of the same general dimensions and construction. 1000 w. Eng Rec—Feb 27, 1909. No. 2846.

The Gmünder Bridge near Teufen, Switzerland (Die Gmündertobel-Brücke bei Teufen in Kanton Appenzell). E. Mörsch. Illustrated description of a high reinforced concrete arch of 79 metres span. Serial. 1st part. 1700 w. Schweiz Bau—Feb. 13, 1909. No. 3384 B.

See also Arches, Culverts and Foundations, under BRIDGES.

**Steel.**

Parabolic Bridges (Ponts paraboliques). A. Nachtergal. A mathematical and graphical demonstration of the method of determining length of members. Ills. 2000 w. All Indus—Feb., 1909. No. 3326 D.

Light and Heavy Bridges (Ponts lourds et Ponts légers). M. Pendaries. Describes two types of light, strong and cheap bridges, of steel girders, reinforced with concrete. Ills. 10000 w. Ann d Ponts et Chaussées—1908-VI. No. 3314 E + F.

Recent Short-Span Highway Bridges. Illustrated description of bridges at Ithaca, N. Y., carrying Buffalo and Seneca Streets over the Cayuga Inlet. 1300 w. Eng Rec—March 27, 1909. No. 3540.

The New Railroad Bridge at Vancouver. J. Mayne Baltimore. Brief illustrated description of the largest, longest and most expensive railway bridge on the American continent. 700 w. Sci Am Sup—Feb. 27, 1909. No. 3576.

The King Edward VII Bridge, Newcastle on Tyne. Frank William Davis

and Cyril Reginald Sutton Kirkpatrick. Describes the foundations, approaches, superstructure and its erection, cableways, etc. Ills. Discussion. 27000 w. Inst of Civ Engrs—No. 3742. No. 3210 N.

I. The Curzon Bridge at Allahabad. Robert Richard Gales. II. The Netravati Bridge at Mangalore. Archibald Scott Napier. General description of construction and costs of two bridges in India. Discussed together. 35800 w. Plates. and Ills.—Inst of Civ Engrs—No. 3626 and No. 3733. No. 3208 N.

See also Concrete, Erection, Floors, Reinforced Concrete, Suspension, and Viaducts, under BRIDGES.

**Suspension.**

The Gisclard Suspension Bridge over the Cassagne (Pont suspendu fixe, Système Gischard, de la Cassagne, Pyrénées-Orientales). G. Leinekugel Le Cocq. Illustrated description of the structure and its construction. Serial. 1st part. 4000 w. Génie Civil—Feb. 20, 1909. No. 3344 D.

The Trellins Suspension Bridge (Notice sur la Construction du Pont suspendu de Trellins près Vinay). M. Buisson. Describes a bridge of the "semi-rigid" type. Ills. 3800 w. Ann d Ponts et Chaussées—1908-VI. No. 3315 E + F.

**Viaducts.**

The Bear River Viaduct; Nevada County Narrow Gauge R. R., Colfax, Cal. Brief illustrated description of a viaduct containing a double cantilever construction of novel design. 1000 w. Eng News—March 11, 1909. No. 3100.

The Greenville Bridge of the Boston & Maine Railroad. Illustrates and describes the erection of a steel viaduct over 611 ft. long, carrying a single track nearly 100 ft. above the Sonhegan River. 2000 w. Eng Rec—Feb. 27, 1909. No. 2850.

The Sixth Street Viaduct, Kansas City. E. E. Howard. Illustrated detailed description of a steel structure, about 8000 ft. long, carrying elevated roadway and two car tracks across the valley of the Kaw River. 17500 w. Pro Am Soc of Civ Engrs—Feb., 1909. No. 3459 E.

## CONSTRUCTION.

**Caissons.**

Pneumatic Caissons on the North-South Line of the Paris Subway. William F. Johnston. An illustrated description of the caisson work in the river beds and the two large underground stations in the Cité and in Place St. Michel. 2500 w. Eng Rec—Feb. 27, 1909. No. 2844.

**Cement Brick.**

A Mill Building of Cement Brick Construction for the Plymouth Cordage Co. A. M. Bradford. Illustrated description. 2500 w. Eng News—March 18, 1909. No. 3240.

**Concrete.**

Mixing and Placing Concrete by Hand. Percy H. Wilson. Bulletin No. 20, Assn. of Am. Portland Cement Mfrs., issued to give practical instruction concerning concrete. Ills. 6000 w. Cement—Feb., 1909. No. 3002 C.

Cost of Concrete Work in the U. S. Reclamation Service. Henry A. Young. Refers to work on tunnel No. 3 of the Huntley Project, Montana. 1200 w. Cornell Civ Engr—March, 1909. No. 3199 C.

The Floating Concrete Plant Used on the Detroit River Tunnel. Newton C. Farr. Describes the plant for placing concrete around the tubes sunk in the river to form a tunnel for the Mich. Cent. R. R. Ills. 1200 w. Cornell Civ Engr—March, 1909. No. 3200 C.

**Cost Keeping.**

A System of Cost Keeping. Myron S. Falk. An explanation of the Accounting System. 1200 w. Pro Am Soc of Civ Engrs—March, 1909. No. 3497 E.

**Earthwork.**

Earthworks. On the importance of earthworks and their proper treatment, especially in railway construction; the angle of slope, material, etc. 1500 w. Engr, Lond—March 12, 1909. No. 3427 A.

See also same title, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

**Factories.**

A New Building for the Western Electric Company. Illustrated description of a fireproof factory building in Chicago, having 500,000 sq ft. of available floor space, to be used for the manufacture of telephone apparatus. 2500 w. Eng Rec—Feb. 27, 1909. No. 2853.

**Failures.**

Failure of a Reinforced Concrete Reservoir at Annapolis. R. A. Danforth. A detailed description of the construction, the failure, and repair. Ills. 2200 w. Eng Rec—March 13, 1909. No. 3107.

**Fertilizer Plants.**

Fertilizer and Acid Plants. F. E. Mac Knight. A brief résumé of the history and statistics of this industry, discussing the constructional features of the plants with special reference to the fire hazards. Ills. 3500 w. Ins Engng—March, 1909. Serial. 1st part. No. 3499 C.

**Fireproof.**

See Clay-Products Testing, under MEASUREMENT.

**Foundations.**

A Test Loading of the Strauss Concrete Pile Foundation (Eine Probebelastung mit dem Betonpfahl-Gründungssystem "Strauss"). Otto Colberg. Describes

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the system and the tests and gives results. Ills. 2000 w. Beton u Eisen—Feb. 23, 1909. No. 3552 F.

**Piling.**

Steel Sheeting and Sheet Piling. L. R. Gifford. A study of the essentials of a satisfactory steel piling, and an analysis of some of the principal sections in use. Ills. 3000 w. Pro Am Soc of Civ Engrs—Feb., 1909. No. 3458 E.

Cast Reinforced Concrete Piles. Sanford E. Thompson and Benjamin Fox. Gives description of the design, construction and data on driving cast reinforced concrete piles for a foundation of the Boston Woven Hose and Rubber Co.'s new power plant in Cambridge, Mass. Ills. Discussion. 7000 w. Jour Assn of Engng Socs—Jan., 1909. No. 3223 C.

Concrete Piles Used in the Steamship Terminals at Brunswick, Ga., and in Navy Yard Pier at Charleston, S. C. M. M. Cannon. A description of the pile work. Ills. Discussion. 4500 w. Jour Assn of Engng Socs—Jan., 1909. No. 3224 C.

**Reclamation.**

The Reclamation of an Extension to Lincoln Park, Chicago. Outline of methods used. 2000 w. Eng Rec—Feb. 27, 1909. No. 2852.

The Drainage and Reclamation of the Zuider Zee (Het Wetsontwerp voor den Aanleg van een Gedeelte van de Afsluiting der Zuiderzee en indijking en droogmaking van de Wieringermeer). Dr. J. Kraus. A comprehensive general review of the project. 7800 w. De Ingenieur—Feb. 20, 1909. No. 3575 D.

**Record Systems.**

An Efficient Index System for City Engineers' Offices. William Gavin Taylor. Read before the Connecticut Soc. of Civ. Engrs. Remarks on various systems, with explanation of the filing system developed by the writer. 2200 w. Eng Rec—March 20, 1909. No. 3270.

**Reinforced Concrete.**

Diagrams for Reinforced Concrete Beams. H. O. Schermerhorn. Inset plate of diagrams, with explanation and review of the principles of design as far as is necessary to show the deduction of the equations. Illustrates their use. 2500 w. Eng Rec—March 6, 1909. No. 2974.

A Method of Designing Reinforced Concrete Beams (Note sur une Méthode de Calcul des Poutres en Ciment armé). M. Pigeaud. A mathematical demonstration. Ills. 9600 w. Ann des Ponts et Chaussées—1908-VI. No. 3312 E + F.

A Reinforced Concrete Interlocking Tower. Illustrates and describes a tower, designed for a 48 lever machine. 1000 w. Sig Engr—March, 1909. No. 3238.

A Reinforced Concrete Church in Los Angeles, Cal. Illustrates and describes the methods of construction, especially the reinforcement of the dome and supporting columns. 1000 w. Eng Rec—March 20, 1909. No. 3267.

Reinforced Concrete in the Zeppelin Air Ship Shed Competition (Der Eisenbeton im Wettbewerb um die Luftschiff-Bauhalle Zeppelins). Illustrates and describes designs for an immense arched structure. Serial. 1st part. 1800 w. Deutsche Bau—Feb. 6, 1909. No. 3382 B.

See also Failures, Piling, and Underpinning, under CONSTRUCTION; Septic Tanks, under MUNICIPAL; Lighthouses, under WATERWAYS AND HARBORS; Barges, under MARINE AND NAVAL ENGINEERING; Shafting, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION; and Timbering, under MINING AND METALLURGY, MINING.

**Steel.**

Secondary Stresses in Framed Structures. E. W. Pittman. Calls attention to faults in structural details causing these stresses, illustrating their effects on the strength of the structures. Discussion. 8000 w. Pro Engrs' Soc of W Penn—Feb., 1909. No. 3455 D.

The Extension to Masonic Hall, New York City. Illustrated detailed description of a steel-cage office structure of 21 stories. 2000 w. Eng Rec—March 13, 1909. No. 3105.

The Allegheny County Soldiers' Memorial. Section, plans and description of a fireproof public building in Pittsburg, having interesting features of structural steel work. 2200 w. Eng Rec—March 6, 1909. No. 2972.

Steel Construction in the New Kiel Theatre (Eisen-Konstruktionen im neuen Stadttheater in Kiel). O. Leitholf. Illustrated description of a complicated structure. Serial. 1st part. 2300 w. Deutsche Bau—Feb. 20, 1909. No. 3383 B.

See also Derricks, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

**Tunnels.**

The Detroit River Tunnel. Illustrates and describes this interesting work. 2500 w. Engr, Lond—Feb. 19, 1909. No. 2898 A.

Methods and Cost of Constructing the New Raton Tunnel for the Atchison, Topeka & Santa Fe Ry. Co., at Raton Pass, New Mexico. Jos. Weidel. Ills. 4000 w. Engng-Con—March 3, 1909. No. 3024.

The Railway Through Mont Blanc. Discusses this project of constructing a new international railway through the Western Alps. 4000 w. Bul Int Ry Cong—Feb., 1909. No. 3281 G.

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The Catastrophe at the Lötschberg Tunnel. A. Trautweiler. An illustrated article describing the inburst of July 24. 2800 w. Bul Int Ry Cong. Feb., 1909. No. 3280 G.

See also Concrete, under CONSTRUCTION; Drilling, under MINING AND METALLURGY, MINING; and Subways, under STREET AND ELECTRIC RAILWAYS.

**Underpinning.**

Underpinning a Building With a Concrete Girder 105 Feet Long. Illustrated description of the methods employed in building a large concrete girder at Evansville, Ind., for the water works pumping station foundation. 1500 w. Eng News—March 4, 1909. No. 2995.

**Wage Systems.**

See same title, under INDUSTRIAL ECONOMY.

**Waterproofing.**

Waterproofing Reinforced Concrete Coal Bunkers. A. T. Schreiber. Describes interesting work in Philadelphia, illustrating the use of Wunners bitumen-emulsion waterproofing. 1800 w. Eng Rec—Feb. 27, 1909. No. 2849.

## MATERIALS OF CONSTRUCTION.

**Brick.**

The Strength and Absorption of Brick, and a Comparison Between Different Methods of Determining Absorption. Reviews two papers by James E. Howard, read before the Nat. Brick Mfrs. Assn. 1200 w. Eng News—March 11, 1909. No. 3104.

**Cement.**

The Action of Sea and Fresh Water on Cement and Concrete. Ernest R. Matthews. Gives conclusions reached by three well-known authorities after a series of tests, and also particulars of the writer's experiments. 3000 w. Surveyor—March 12, 1909. No. 3407 A.

See also Drainage, under MUNICIPAL.

**Concrete.**

Progress Report of Special Committee on Concrete and Reinforced Concrete. A report of the present judgment of the Committee concerning the proper use of these materials. 10500 w. Pro Am Soc of Civ Engrs—Feb., 1909. No. 3457 E.

See also Cement, under MATERIALS OF CONSTRUCTION.

**Mortars.**

Calcium Aluminates; Their Effect on Mortars. Henry S. Spackman. Gives analyses and tests with results. 4000 w. Jour Fr Inst—March, 1909. No. 3250 D.

**Reinforced Concrete.**

Rupture Tests of Reinforced Concrete Beams by N. Rella and Neffe, Vienna (Die Bruchversuche mit Plattenbalken der Betonbauunternehmung N. Rella und Neffe, Wien). Describes tests on T beams, reinforced in various ways, and gives results. Ills. 3750 w. Beton u Eisen—Feb. 23, 1909. No. 3553 F.

**Steel.**

See Blackwell's Island, under BRIDGES.

**Timber.**

Properties of the Usual Sections of Timber. George M. Adams. Read before the Transvaal Inst. of Mech. Engrs. Gives tabulated results of calculations explaining applications. 700 w. Mech Engr—March 12, 1909. No. 3410 A.

Improved Methods of Bleeding Pine Trees for Turpentine and Rosin. A description of old and new methods, and report of U. S. Forest Service tests of the natural and bled timber. Ills. 700 w. Eng News—March 18, 1909. No. 3243.

**Timber Preservation.**

The Relation of Non-Pressure Processes of Wood Preservation to Pressure Processes. W. F. Sherfesee. Shows that the non-pressure simplifies both the processes and the mechanical equipment, and that they do not compete with the pressure processes. Ills. 3300 w. Eng News—March 4, 1909. No. 2994.

A Modern Timber Treating Plant. Illustrated description of the plant of the Santa Fé at Somerville, Texas, for treating ties by Rueping process. 2000 w. Met Work—March 20, 1909. No. 3258.

Tie Treatment with Crude Oil on the Mexican Central. Describes the process used at Aguascalientes, Mexico, giving experimental results. 2000 w. R R Age Gaz—March 26, 1909. No. 3518.

## MEASUREMENT.

**Asphalt Testing.**

Testing Asphalt—Melting Point and Flow Point. Henry Tipper. Considers the value of these tests. 2800 w. Munic Jour and Engr—March 3, 1909. No. 2933.

**Cement Testing.**

The Importance and Cost of Current Testing. W. Purves Taylor. Read before the Nat. Assn. of Cement Users. Shows the value of well-made tests, and the danger of cheaply made tests. 1500 w. Cement—Feb., 1909. No. 3003 C.

Progress Report of Special Committee on Uniform Tests of Cement. Illustrates and describes experimental investigations. 4000 w. Pro Am Soc of Civ Engrs—Feb., 1909. No. 3456 E.

**Clay-Products Testing.**

Testing Clay Products. A. V. Bleininger. Gives an outline of tests to be made at Pittsburg laboratories to determine their fire-resisting properties. 1600 w. Ins Eng—March, 1909. No. 3500 C.

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**Concrete Testing.**

A New Test for Concrete. J. S. Owens. Describes the origin and application of a new test for determining the end of the mixing process in preparing concrete. 6000 w. Soc of Engrs—March 1, 1909. No. 3284 N.

**Soil Testing.**

Tests of Soil for Use in Constructing an Earth Dam for a Water-Works Reservoir, Baltimore, Md. Emory Sudler. Describes method used in testing soil in the construction of a large storage reservoir, with tabulated results. 1000 w. Eng News—March 25, 1909. No. 3490.

**Surveying.**

The History of Land Measurement in England. Wilfrid Airy. A review of the early practice. 2800 w. Engng—March 12, 1909. No. 3416 A.

**Testing Machines.**

Special Features of a Recently Installed 600,000-lb. Universal Testing Machine. Thorsten Y. Olsen. From Pro. Am. Soc. for Test. Materials. Description, with illustrations, and methods of testing. 2500 w. Sib Jour of Engng—Feb., 1909. No. 3252 C.

## MUNICIPAL.

**Asphalt Plants.**

Municipal Asphalt Plants. Illustrated descriptions of plants in various cities of the U. S. and Canada. 5000 w. Munic Jour & Engr—March 3, 1909. No. 2932.

Recent Operations of the New Orleans Municipal Asphalt Repair Plants. From a report by Capt. W. J. Hardee. 1600 w. Eng Rec—March 13, 1909. No. 3111.

**City Charters.**

Charter Making and Mending in New York, Boston, and Berkeley, Cal. Gives information in regard to the proposed charters for the cities named, with editorial discussion. 15500 w. Eng News—March 25, 1909. No. 3494.

**City Planning.**

Improvement of Town Suburbs. George Cowan. Presents the need of town planning, discussing some of the difficulties and problems. 3000 w Surveyor—Feb. 19, 1909. No. 2884 A.

**Sewers.**

Town and Country: Some Aspects of Town Planning. H. V. Lanchester. Discusses town improvements, street planning, decorative effects, park systems, etc., with special reference to England. Ills. Discussion. 10000 w. Jour Roy Inst of Brit Archts—Feb. 20, 1909. No. 3115 C.

**Drainage.**

Relation of Portland Cement to Iowa's Drainage Development. A. O. Anderson. Read before the Iowa Assn. of Cement Users. Reports tests made of cement tile, showing their reliability. 1500 w. Cement Age—March, 1909. No. 3449.

An Additive Method of Computing Run-Off to Sewers. Carl H. Nordell. Read before the Munic. Engrs. of the City of N. Y. Reviews briefly various methods developed, and gives a detailed description of the additive method. Diagrams. 4500 w. Eng News—March 11, 1909. No. 3102.

A Note on the Design of Storm-Water Drainage Sewers (Beitrag zur Berechnung von Ueberfällen bei Regenauslassen). Prof. Frühling. A mathematical discussion. Ills. 4000 w. Gesundheits-Ing—Feb. 6, 1909. No. 3387 D.

See also Sewers, under MUNICIPAL.

**Pavements.**

Machinery for the Maintenance of Street Pavements in Paris. Jacques Boyer. Reviews the latest developments in methods and machines for pavement construction and repair, and for street cleaning. Ills. 4000 w. Engineering Magazine—April, 1909. No. 3526 B.

Amount and Cost of Repairs to Asphalt Pavements at Syracuse, N. Y., and Proper Method of Determining Time for Ceasing Repairs and Renewing. From the annual report of the City Engineer, H. C. Allen. 1200 w. Engng-Con—March 3, 1909. No. 3025.

Brick Paving and Street Railway Track Construction at Champaign, Ill. Particulars from a paper by G. C. Fairclo, read before the Ill. Soc. of Engrs. and Survs. Ills. 1500 w. Eng News—March 18, 1909. No. 3241.

See also Asphalt Plants, under MUNICIPAL; and Asphalt Testing, under MEASUREMENT.

**Public Baths.**

The Wiesbaden Public Baths (Entwicklung und Betrieb der Volksbadeanstalten in Wiesbaden). B. Berlit. Describes the buildings, their equipment, etc. 8000 w. Gesundheits-Ing—Feb. 20, 1909. No. 3390 D.

**Refuse Disposal.**

Acton Refuse Destructor. C. J. Yorath. Illustrated detailed description of a plant for a rapidly growing district. 3500 w. Surveyor—March 5, 1909. No. 3158 A.

The Edinburgh Corporation's Cleaning Department. G. A. D. Mackay. An account of methods of collecting and disposing of waste, the cost, and matters related. 3500 w. Pub Works—Oct-Dec, 1908. No. 3594 B.

**Roads.**

Highway Administration and Reform. Discusses conditions in England, the need of reforming the present system of ad-

*We supply copies of these articles. See page 319.*

ministration, with suggestions. 3000 w. Surveyor—Feb. 26, 1909. No. 3057 A.

Some Methods of Modern Road Construction. George W. Manning. From a paper before the Midland Assn. of Loc. Gov. Officers. Suggestions as to what should be done to fit English roads for modern requirements. 2500 w. Surveyor—Feb. 26, 1909. No. 3058 A.

The Construction and Maintenance of Roads. Albert V. Hart. The effect of self-propelled vehicles on roads is discussed, the stability of road surfaces, repair work, and cost of maintenance. 3500 w. Surveyor—Feb. 19, 1909. No. 2883 A.

Economic Hints for Macadam Road Contractors. 1800 w. Engng-Con—March 3, 1909. Serial. 1st part. No. 3026.

The Preparation of Macadam. Donald M. D. Stuart. A report of investigations on preparation of crushed stone. 2500 w. Surveyor—Feb. 19, 1909. No. 2881 A.

Recent Maintenance Work of the Massachusetts Highway Commission. Describes experiments made to determine what method of construction should be used to prevent undue damage by automobiles and prevent intolerable dust. 6000 w. Eng Rec—March 20, 1909. No. 3273.

Boulder Stones in Southern Ontario—Their Road-Making Qualities. Andrew F. Macallum, and T. Aird Murray. Discusses the materials at hand for making good roads in Southern Ontario. 2200 w. Can Engr—March 5, 1909. No. 3004.

Sampittic Surfacing. Walter Wilson Crosby. Submits specifications for "Sampittic Surfacing" as, in the writer's opinion, the simplest form of the use of a hydrocarbon cement. 2200 w. Pro Am Soc of Civ Engrs—Feb., 1909. No. 3460 E.

**Sanitation.**

The Status of the Modern Sanitary Engineer. George W. Chilvers. Reviews recent progress in sanitation. 4000 w. Surveyor—March 19, 1909. No. 3606 A.

**Septic Tanks.**

A Reinforced-Concrete Pressure Sedimentation Tank. Harold D. Elfreth. Illustrated detailed description of the construction and operation of a plant at Whitehall, N. Y. 1600 w. Eng News—March 25, 1909. No. 3492.

**Sewage Disposal.**

The Sewage Disposal Works of Baltimore. Plan and description of the general arrangement of the works. 2000 w. Eng Rec—Feb. 27, 1909. No. 2848.

Merchants' Association Plans for Treating New York Sewage Beneath the Street Surface. Explains the proposed plan. Also editorial discussion. 2500 w. Eng News—March 4, 1909. No. 3001.

The Problem of Sewage Disposal. W. D. Scott-Moncrieff. First of a series of four lectures at the Univ. of London. Reviews the history of sanitation in England. 8000 w. Surveyor—March 12, 1909. Serial. 1st part. No. 3408 A.

The Treatment of Sewage. Harold Pritchard. Remarks on recent works, describing a small installation in the rural district of Burnley. Discussion. 3000 w. Surveyor—Feb. 19, 1909. No. 2882 A.

Small Sewage Purification Plants (Die Abwasserreinigung im Kleinbetrieb). Dr. A. Lübbert. Reviews a number of small plants for hotels, villages, etc., with comments on current practice. Ills. Serial. 1st part. 2500 w. Gesundheits-Ing—Feb. 27, 1909. No. 3391 D.

The Purification of Sewage by Intensive Biological Treatment (Épuration des Eaux d'Égout par le Procédé biologique intensif). M. B. Bezault. A comparison with the filtration process. Ills. 12000 w. Mem Soc Ing Civ de France—Dec., 1908. No. 3301 G.

Composition, Tests, and Utilization of Colombes Sewage Residues (Analyses et Expériences sur les Boues de Colombes et Remarques sur leur Utilisation). E. Damour. An examination of the possibility of using sewage residues in the gas producer. 3100 w. Bul Soc d'Encour—Jan., 1909. No. 3311 G.

The Sewer System of San Francisco, and a Solution of the Storm-Water Flow Problem. C. E. Grunsky. Describes the topography and conditions to be met, the design of a sewer system, methods of estimating capacity, types of sewers, etc. Maps. 28000 w. Pro Am Soc of Civ Engrs—March, 1909. No. 3495 E.

See also Culverts, under BRIDGES; and Drainage, under MUNICIPAL.

## WATER SUPPLY.

**Analysis.**

Analytical Reports on Water Samples. Fred A. Anderson. A discussion designed for engineers who have to use the results of water analyses as reported by chemists. 2500 w. Elect'n, Lond—Feb. 19, 1909. Serial. 1st part. No. 2879 A.

**Aqueduct.**

Repairs to the Cher River Crossing of the Berry Canal (Réparation du Pont Canal de la Tranchasse). M. Barrat. Report on repair work on this aqueduct in France. Ills. 11200 w. Ann d Ponts et Chaussées—1908-VI. No. 3317 E + F.

**Barrages.**

The Isna Barrage Across the Nile. Illustrated description of this important irrigation work in Egypt. 2500 w. Sci Am—March 6, 1909. No. 2970.

**Dams.**

A Sketch of the Recent Development of Movable Dams. Albert B. Cudebec. Outlines the important types giving a gen-

eral idea of the present development. 1500 w. Cornell Civ Engr—March, 1909. No. 3201 C.

The Ohio River Dam and Lock No. 37, Near Cincinnati, O. Illustrated detailed description of important engineering work in connection with the improvement of river navigation. 5000 w. Eng News—March 4, 1909. No. 2996.

Needle Dam, Pleasanton Reclamation Project, California. James K. James. Outlines the aims of this project and gives an illustrated description of this movable dam, discussing the hydrostatic pressures when the dam is full. 3500 w. Cal Jour of Tech—Feb., 1909. No. 3501.

The Chuviscar Dam of the Chihuahua Water Works. A concrete dam, faced with dressed stone, to impound flood waters as a reserve for water supply. Describes method of treating a cavern crossing the site of the dam. Ills. 2000 w. Eng Rec—March 27, 1909. No. 3539.

The Construction of Three Reservoir Dams in the Valley of the Ondaine (Note sur la Construction de trois Barrages-Réservoirs dans la Vallée de l'Ondaine). M. Reuss. The structures are of masonry. 10000 w. Ann des Ponts et Chaussées—1908-VI. No. 3313 E + F.

See also Soil Testing, under MEASUREMENT.

**Ditches.**

Ditches. Douglas Waterman. A discussion of the most economic ditch section. Ills. 1500 w. Min & Sci Pr—March 6, 1909. No. 3091.

**Filtration.**

The Puech-Chabal System of Filtration. Photographs and sectional drawing of the plant installed at Magdeburg, with description of the system. 800 w. Engng—Feb. 26, 1909. No. 3065 A.

Water Filtration at Springfield, Mass. An illustrated account of the difficulties overcome in the construction and operation of the Ludlow filters. 2500 w. Munic Jour & Engr—March 17, 1909. No. 3182.

**Fire Protection.**

San Francisco's Fire Service. David Paul. Describes a new and efficient service to be installed at an expense estimated at $5,250,000. 2200 w. Sci Am Sup—March 26, 1909. No. 3580.

**Irrigation.**

The Relations of Irrigation to Navigation. F. W. Hanna. Considers that the irrigation canals in arid regions are not likely to ever be used for navigation, but points out their beneficial influence by increasing production of agricultural products, preventing floods, etc. 1200 w. Eng News—March 25, 1909. No. 3491.

Nile Reservoirs and the Cotton Crop. Sir William Willcocks. Describes the reservoirs on the White Nile and discusses their best utilization for the advantage of Egypt and the Sudan. 7000 w. Pub Works—Oct-Dec., 1908. No. 3592 B.

Irrigation in the South-Western Districts of the Transvaal. Harben Robert Young. Describes some irrigation problems and the principal irrigation surveys in the south-western districts, not including the Vaal River. Ills. 4000 w. Pub Works—Oct.-Dec., 1908. No. 3590 B.

**Magdeburg.**

The Elbe Water of Magdeburg. Information from a recent paper by Dr. Otto Pfeiffer, before the Verein Deutscher Ingenieure, concerning the conditions, sources of contamination, etc. 2500 w. Engng—Feb. 19, 1909. No. 2896 A.

**New York State.**

The Water Supplies of New York State. H. D. Pease. A discussion of the aspects of the subject as related to the work of the State Board of Health. General discussion. 6500 w. Jour N Eng W-Wks Assn—March, 1909. No. 3633 F.

**Paris.**

The Water Supply of Paris. Notes from a pamphlet by Easton Devonshire, describing the complex system. 4000 w. Eng Rec—Feb. 27, 1909. No. 2847.

**Pipe Lines.**

The Pipe Line and Purification Works and Experiments of the Baltimore County Water & Electric Co., Maryland. A. E. Walden. An illustrated description of improvements, tests, etc. 4000 w. Eng News—March 18, 1909. No. 3239.

**Pipes.**

Wrought-Iron Cement-Lined Water Pipe. Leonard Metcalf. A summary of acquired data with illustrated description of methods of manufacture and discussion of merits and demerits. General discussion. 30500 w. Jour N Eng W-Wks Assn—March, 1909. No. 3632 F.

**Port Elizabeth.**

I. Survey for Port Elizabeth Water Supply. Charles Dimond Horatio Braine. II. Port Elizabeth Water-Supply. William Ingham. Two illustrated papers giving a history and description of the water works. 9500 w. Inst of Civ Engrs—No. 3747 & No. 3756. No. 3203 N.

**Purification.**

The Forbes Water-Sterilizer. Drawings and description. 1600 w. Engng—March 5, 1909. No. 3173 A.

Poughkeepsie Purification Plant. Robert J. Harding. Drawing and description. 1200 w. Cornell Civ Engr—March, 1909. No. 3198 C.

The Purification of Portable Waters by Ozone (La Stérilisation par l'Ozone des

Eaux potables et les Clarificateurs avec Dégrossisseurs biologiques). M. L. Borne. Describes experiences in France. Ills. 7000 w. Mem Soc Ing Civ de France—Dec., 1908. No. 3300 G.

See also Pipe Lines, under WATER SUPPLY.

**Salt Lake City.**

Water Supply of Salt Lake City. Abstracts of descriptions of the various sources of supply, particularly of the gravity supply, from a report of Louis C. Kelsey, city engineer. Ills. 2500 w. Munic Engng—March, 1909. No. 2929 C.

**Tanks.**

The Design of Elevated Tanks and Stand-Pipes. C. W. Birch-Nord. Submits specifications for the approval of engineers. 1500 w. Pro Am Soc of Civ Engrs—March, 1909. No. 3496 E.

**Water Towers.**

See Tanks, under WATER SUPPLY.

## WATERWAYS AND HARBORS.

**Caissons.**

See same title, under CONSTRUCTION.

**Canals.**

Plans of Bavaria and Württemberg for a Canal to Join the Rhine and the Danube (Die bayerischen und württembergischen Canalpläne für Donau-Rhein-Verbindungen). Herr Steller. A brief review. Ills. 3600 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1909. No. 3565 D.

See also Aqueducts, under WATER SUPPLY.

**Chicago.**

Report of the Chicago Harbor Commission. Extracts covering important points of the recent exhaustive report concerning harbor facilities in the lake and river at Chicago. 4000 w. Ry & Engng Rev—March 20, 1909. No. 3295.

**Costa Rica.**

See same title, under RAILWAY ENGINEERING, MISCELLANY.

**Diving.**

Submarine Experiments of the Past. Franz M. Feldhaus. Illustrates and describes early devices to enable men to work under the water. 1500 w. Sci Am Sup—March 20, 1909. No. 3581.

**Docks.**

The Key Harbor Ore Docks of the Canadian Northern Railway. E. W. Oliver. Illustrates and describes the ore dock, a conveyor trestle and an unloading trestle. 1200 w. Eng Rec—March 20, 1909. No. 3275.

Iron Ore Docks at Aguilas, Spain. Gustave Gillman. From a paper before the Inst. of Civ. Engrs., London. Illustrates and describes steel docks resting on concrete blocks. 2000 w. Ir Age—March 25, 1909. No. 3483.

**Dredges.**

The New Jomini River Dredge (Nouvelle Drague de Rivière Système N. Jomini). M. Lidy. Description of a screw device for levelling river bottoms, which is turned by the force of the current. Ills. 2500 w. Ann d Ponts et Chaussées—1908-VI. No. 3318 E + F.

**Dredging.**

Dredging and the Removal of Submarine Rock at Malta. (Abridged.) Arthur Langtry Bell. Describes the rock breaking appliances, dredging craft, etc., used in deepening and extending the berthing area for warships. Ills. 4500 w. Inst of Civ Engrs—No. 3762. No. 3206 N.

**Dry Docks.**

The Dry Dock. T. M. Brown. Reviews the history of their development, and gives information of interest. 4000 w. Marine Rev—March 11, 1909. No. 3122.

**Frankfort-on-Main.**

The Harbor Works of Frankfort-on-the-Main. Detailed description of the completed and proposed works. 2500 w. Pub Works—Oct.-Dec., 1908. No. 3595 B.

**Georgian Bay Canal.**

Canadian Routes for Deep Waterways to the Atlantic. Brief discussion of the St. Lawrence route as compared with the Georgian Bay project. 1200 w. Eng News—March 4, 1909. No. 2998.

**Lake Ontario.**

Currents and Shore Processes in Lake Ontario. Alfred W. G. Wilson. Special reference to Toronto harbor. 4500 w. Can Engr—March 26, 1909. No. 3535.

**Lighthouses.**

The One Fathom Bank, Ferro-Concrete Lighthouse, Straits Settlements. Alexander Murray, in *Colonial Office Journal.* Illustrated description of a structure in the Straits of Malacca. 1800 w. Cement Age—March, 1909. No. 3450.

Automatic Flash-Light Acetylene Lamp for Lighthouses (Lampe à Acétylène à Allumage et à Extinction automatiques pour Feux à Eclats). Emil Smith. Illustrated detailed description. 1800 w. Génie Civil—Feb. 13, 1909. No. 3342 D.

**Locks.**

A Movable Lock for Inclined Canals. H. Prime Kieffer. Illustrated description of a self-propelled canal-lock, invented by Giuseppe Bartolomei. 1200 w. Sci Am—March 6, 1909. No. 2968.

See also Dams, under WATER SUPPLY; and Cranes, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

*We supply copies of these articles. See page 319.*

**Mississippi River.**

Improvement of the Upper Mississippi River. C. McD. Townsend. The stretch of river from St. Paul to Prescott is described to show the method adopted, and such other parts as illustrate some variation from the general method. Ills. Discussion. 18000 w. Jour W Soc of Engrs—Feb., 1909. No. 3298 D.

**Ohio River.**

See Dams, under WATER SUPPLY.

**Panama Canal.**

The Isthmian Canal. Lieut.-Col. George W. Goethals. From a paper read before the Mfrs. Assn. of Chicago. Explains changes made in the original project for a lock-canal, describing conditions and the progress of the work and defending the type adopted. 4000 w. Eng News—March 18, 1909. No. 3245.

Report of Board of Inspecting Engineers on the Panama Canal. Report and editorial. 6500 w. Eng Rec—Feb. 27, 1909. No. 2854.

Some Further Evidence Respecting the Best Type of Canal for Panama. Presents some of the evidence which supports the lock canal plan. Ills. 3500 w. Eng News—March 4, 1909. No. 2999.

Superiority of Lock to Sea-Level Canal. Gives comparative diagrams showing the physical characteristics of the two types of canal, the quantities, costs, etc. 1600 w. Sci Am—March 27, 1909. No. 3521.

The Panama Canal. Editorial on the agitation in regard to the lock-type of canal. 1800 w. Engng—March 19, 1909. No. 3621 A.

**River Regulation.**

The Hydrological Importance of Forests (Die hydrologische Bedeutung des Waldes). Discusses forests in their relation to the control and conservation of surface waters. 3300 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 27, 1909. No. 3551 D.

**Rock Removal.**

The Removal of Submarine Rock. Harold Berridge. Deals with the survey, disintegration and removal of débris. 6500 w. Inst of Civ Engrs. No. 3767. No. 3207 N.

See also Dredging, under WATERWAYS AND HARBORS.

**Shore Protection.**

Caving Banks. B. M. Harrod. Explains the causes of caving and methods of bank protection. 2000 w. Jour Assn of Engng Socs—Jan., 1909. No. 3225 C.

Method and Cost of Constructing Flexible Revetment for River Bank Protection. Description and cost of a type of revetment used in California. 1400 w. Engng-Con—March 24, 1909. No. 3514.

**Toronto.**

See Lake Ontario, under WATERWAYS AND HARBORS.

**Water Hyacinth.**

The Water Hyacinth Problem. John Klorer. An account of its introduction into the United States in 1884, and the necessity of checking its growth or removing it from streams, with some of the methods. Ills. 2500 w. Jour Assn of Engng Socs—Jan., 1909. No. 3226 C.

**Water Powers.**

A Review of the Water-Powers of Alabama, Chiefly Undeveloped. S. Mays Ball. A statement based on reports made by the U. S. Geol. Survey and the Geol. Survey of Alabama. 4500 w. Elec Rev, N Y—March 20, 1909. No. 3266.

The Utilization of the Water Powers of Germany (Deutschlands Wasserkräfte und ihre technische Auswertung). Richard Hennig. A discussion of the power resources, their economic importance, and the principles on which they should be utilized. Serial. 1st part. 3000 w. Die Turbine—Feb. 20, 1909. No. 3377D.

# ELECTRICAL ENGINEERING

## COMMUNICATION.

**Radiotelegraphy.**

Theory of the Horizontal Transmitting Antenna. Alfredo Montel. Abstract from *La Lumière Electrique*. Presents a simple method of treating the problem of this antenna mathematically. 600 w. Elect'n, Lond—Feb. 19, 1909. No. 2878 A.

The Composition of Electromagnetic Fields and Waves (Sulla Composizione dei Campi e delle Onde elettromagnetiche). A. Artom. A discussion of the author's system of wireless telegraphy. Ills. Serial, 1st part. 2000 w. Elettricita—Feb. 11, 1909. No. 3349 D.

**Radio-telephony.**

The Majorana System of Wireless Telephony. Information concerning the system and some tests made in Italy. Elec Engng—Feb. 25, 1909. No. 3049 A.

**Telegraph Lines.**

The Construction of Overhead Lines in France (Construction des Lignes électriques aériennes). Describes in detail the latest practice in transmission and tele-

graph line construction in France. Ills. Serial, 1st part. 1600 w. L'Eleen—Feb. 20, 1909. No. 3332 D.

**Telegraphy.**

The Kotyra Keyboard Perforator for Wheatstone Automatic Working. Illustrated description of this improved machine and its operation. 1000 w. Elec Rev, Lond—March 19, 1909. No. 3602 A.

**Telephone Cables.**

The Capacity of Paper Condensers and Telephone Cables. With a Note on the Determination of the Specific Inductive Capacity of Dielectrics. A. Zelenny and A. P. Andrews. Abstracted from *Physical Rev.* 700 w. Elect'n, Lond—March 12, 1909. No. 3406 A.

**Telephony.**

The Automatic System of Telephony. W. Lee Campbell. An illustrated discussion of the Strowger system. 5500 w. Jour Fr Inst—March, 1909. No. 3249 D.

Some Applications of the "Domophone" (Quelques Applications du Domophone). J. A. Montpellier. Describes this microphone, its installation and use in private telephone installations. Ills. 2500 w. L'Eleen—Feb. 27, 1909. No. 3333 D.

## DISTRIBUTION.

**Chemical Works.**

Electrical Equipment of the Bergenport Chemical Works. Warren H. Miller. Description of a plant of interest because of the size of the installation units, and the acid corrosive problems. 2500 w. Elec Wld—Feb. 25, 1909. No. 2872.

**Circuit Breakers.**

Trip Coils for Alternating Current Automatic Circuit Breakers. C. C. Garrard. Gives experimental results, considering whether it is not desirable to work entirely with a. c. coils. 1500 w. Elect'n, Lond—Feb. 19, 1909. No. 2877 A.

**Insulation.**

The Linseed Oil Fallacy. Gives facts showing that its oxidation unfits for electrical uses. 1000 w. Elec Rev, Lond—March 5, 1909. No. 3150 A.

See also Wiring, under DISTRIBUTION.

**Switches.**

Oil Switches and Oil Circuit Breakers. William B. Kouwenhoven. Illustrated detailed description, explaining methods of operating. 2500 w. Ry & Loc Engng—March, 1909. No. 2941 C.

**Wiring.**

Utilization of Electrical Energy. Gives general rules adopted for wiring in Victoria. 2500 w. Aust Min Stand—Jan. 20, 1909. Serial, 1st part. No. 3045 B.

Insulation and Wiring. W. H. F. Murdoch. A criticism of some of the required tests in the revised regulations of the Inst. of Elec. Engrs. 800 w. Elec Rev, Lond—Feb. 26, 1909. No. 3052 A.

## DYNAMOS AND MOTORS.

**D. C. Motors.**

Regulating and Braking Resistances for D. C. Motors (Ermittlung der Regulier- und Bremswiderstände für Gleichstrommotoren). Hermann Zipp. Mathematical and theoretical. Serial, 1st part. Electrotech Rundschau—Feb. 3, 1909. No. 3554 D.

See also Electric Power, under MINING AND METALLURGY, MINING.

**Induction Motors.**

A New Method for Regulating the Speed of Induction Motors, and Its Applications. C. Krämer. Abstract translation from *Elek. Zeit.* Describes a method where energy is taken from the rotor and supplied to the axis of the asynchronous machine as mechanical energy. 1500 w. Elect'n, Lond—March 5, 1909. No. 3152 A.

See also Starting, under DYNAMOS AND MOTORS.

**Rheostats.**

Rheostats for Shunt Electrical Machines (Réostatos para Máquinas shunt.) Ricardo Caro. A mathematical discussion. Serial, 1st part. 3000 w. Energia Electrica —Feb. 10, 1909. No. 3347 D.

**Starting.**

A Comparison of the Methods of Starting Squirrel-Cage Induction Motors. Selby Haar. Analyzes the performance when started at lowered voltage obtained respectively by means of auto-transformers and of rheostats in the primary circuits. Also letter by Dr. C. P. Steinmetz. 1500 w. Elec Wld—March 11, 1909. No. 3086.

Auto-Transformers versus Rheostats for Induction Motor Starters. I. E. Hanssen. Discusses some of the advantages and disadvantages of the two types. 1700 w. Elec Wld—Feb. 25, 1909. No. 2870.

See also Rheostats, under DYNAMOS AND MOTORS.

## ELECTRO-CHEMISTRY.

**Calcium Carbide.**

The Manufacture of Calcium Carbide (Le Carbure de Calcium, Etat actuel de la Fabrication). M. Pitaval. A historical résumé, with a review of the latest methods and apparatus. Ills. 4800 w. Génie Civil —Feb. 6, 1909. No. 3339 D.

Practical Considerations on the Modern Electric Furnace for the Manufacture of Calcium Carbide (Considerazioni pratiche sui Forni elettrici moderni per la Fabbricazione del Carburo di Calcio). Arturo Pavloni. Serial, 1st part. 1600 w. Elettricita—Feb. 11, 1909. No. 3348 D.

**Cleaning Baths.**

Electric Cleaner for Use with Low Voltage Current. Describes its use for cleaning iron or steel to be plated. 1800 w. Brass Wld—March, 1909. No. 3444.

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**Corrosion.**

Experiments on the Corrosion of Steel in Contact with Bronze in Sea-Water. Edward C. Sherman. A report of experiments made in connection with the work on the Charles River dam, at Boston, showing the protection afforded by a proper use of zinc. Also a study of the corrosion of submerged steel in contact with other metals. 1800 w. Eng News—March 18, 1909. No. 3242.

Corrosion of Iron and Steel. Edward Crowe. Abstract of a paper and discussion before the Cleveland Inst. of Engrs. Investigates some of the conditions under which relative rates of corrosion take place, suggesting protective methods. 2500 w. Ir & Coal Trds Rev—March 5, 1909. No. 3179 A.

**Detinning.**

The Detinning Industry. Briefly considers electrolytic detinning, chlorine detinning, and detinning of old cans. Ills. 2200 w. Ir & Coal Trds Rev—March 19, 1909. No. 3628 A.

**Electro-Metallurgy.**

Reduction of Refractory Oxides, Production of Ferro-Alloys, and Formation of Carbides. Gives a summary of results obtained in recent researches at the Univ. of Manchester. 3000 w. Elec-Chem & Met Ind—March, 1909. No. 2989 C.

## ELECTRO-PHYSICS.

**Alternating Currents.**

Even Harmonics in Alternating-Current Circuits. Charles P. Steinmetz. Shows that it is incorrect to assume that even harmonics are never present, citing examples. 700 w. Elec Wld—March 25, 1909. No. 3513.

The Dielectric Strength of Compressed Air. E. A. Watson. Experimental investigations to determine the manner in which the dielectric strength of air changes when compressed to pressures higher than atmospheric. 4500 w. Inst of Elec Engrs—March, 1909. No. 3283 N.

**Dielectric Strength.**

See also title, under MEASUREMENT.

**Hysteresis.**

Dependence of Magnetic Hysteresis Upon Wave Form. Morton G. Lloyd. Describes investigations made, the apparatus used, and states the conclusions. 7000 w. Bul Bureau of Stand—Feb., 1909. No. 3286 N.

**Magnetic Properties.**

Researches on the Magnetic Properties of a Series of Carbon Tungsten Steels. T. Swinden. Read before the Leeds Sec. of the Inst. of Elec. Engrs. Describes a continuation of investigation into the properties of a series of constant-tungsten increasing-carbon steels. 2000 w. Elect'n, Lond—March 12, 1909. No. 3404 A.

**Oscillations.**

The Coefficient of Reflection of Electrical Waves at a Transition Point. Louis Cohen. Mathematical development of expressions for the ratios of the reflected and transmitted waves to the incoming waves at a transition point. 800 w. Elec Wld—March 11, 1909. No. 3085.

## GENERATING STATIONS.

**Central Stations.**

Features of Recent Electric Railway Power Station Design. An illustrated comparison of stations built in the last six years, showing general tendencies of arrangement and equipment. 2000 w. Elec Ry Jour—March 27, 1909. No. 3508.

Bennings Power House of Potomac Electric Co. F. L. Johnson. Illustrated description of a station in the District of Columbia, which furnishes current for lighting and power. 2500 w. Power—March 30, 1909. No. 3585.

Building and Boiler Plant of Waterside Station No. 2 of the New York Edison Company. Illustrated detailed description of the building and its equipment, with a comparison with Waterside Station No. 1. 4000 w. Elec Wld—March 4, 1909. No. 2991.

Main and Auxiliary Steam Equipment in Waterside Station No. 2 of the New York Edison Company. Illustrated description of the feed-water system, high-pressure steam piping, exhaust and drip piping, and oiling system. 3500 w. Elec Wld—March 11, 1909. No. 3084.

Leeds Electricity Undertaking. Illustrates and describes extensions to the lighting station for power supply purposes. 2500 w. Elect'n, Lond—March 12, 1909. Serial. 1st part. No. 3405 A.

See also Gas Power Plants, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

**Design.**

Power House Design from an Insurance Viewpoint. From an article by C. B. MacKinney. 1500 w. Eng Rec—March 13, 1909. No. 3109.

See also Power Plants, under MECHANICAL ENGINEERING. POWER AND TRANSMISSION.

**Hydro-Electric.**

The Cost of Installation and Operation of Hydro-Electric Plants (Notes sur le Cout d'Etablissement et d'Exploitation des Usines hydraulico-électriques). J. Izart, from an article by K. Thielsch in the *Zeitschrift für das gesamte Turbinenwesen*. Ills. Serial. 1st part. 2000 w. L'Elecn—Feb. 6, 1909. No. 3330 D.

The M'Call's Ferry Hydro-Electric Power Plant. William Allen. Brief illustrated description of work under construction, costing about $10,000,000. 1500 w. Sci Am—March 13, 1909. No. 3132.

*We supply copies of these articles. See page 319.*

Work on the McCall's Ferry Hydroelectric Development. Henry Hale. An illustrated account of this large plant on the Susquehanna River. 2000 w. Elec Rev, N Y—Feb. 27, 1909. No. 2855.

Hydroelectric Plant of the Schenectady Power Company. C. T. Wilkinson. An illustrated detailed description of the Schaghticoke development on the Hoosic River. 3000 w. Elec Rev, N Y—March 27, 1909. No. 3530.

The Hydro-Electric Plant of the Connecticut River Power Company. Illustrated detailed description of a development to furnish power for cities in Massachusetts, New Hampshire and Vermont, over a radius of 60 miles. 3000 w. Eng Rec—March 27, 1909. No. 3536.

Great Falls, Montana. Brief illustrated description of the different falls and power plants. 2000 w. Mines & Min—March, 1909. No. 2952 C.

Hydraulic-Power Development on the Pacific Coast. Frederic A. C. Perrine. Explains the peculiar climatic and meteorological conditions affecting power development in California. 3000 w. Cassier's Mag—March, 1909. No. 2925 B.

The Hydro-Electric Developments of the Nevada-California Power Company. H. D. Chapman. Illustrated detailed description of the developments in Inyo County, Cal., utilizing the waters of Bishop Creek, and furnishing power for Nevada mines. 2500 w. Eng Rec—March 6, 1909. No. 2971.

Water Power Plants in Sweden and Norway. A description of the more important plants completed and projected. Ills. 4500 w. Engng—March 12, 1909. Serial. 1st part. No. 3417 A.

The Montcherand Hydro-Electric Plant (L'Usine hydro-électrique de Montcherand). P. Schmetz and V. Abrezol. Illustrated detailed description of a 4,000 horse power plant. Serial. 1st part. 1000 w. Bul Tech d l Suisse Romande—Feb. 25, 1909. No. 3335 D.

**Isolated Plants.**

Central Stations versus Private Plants. Editorial discussion of how to decide as to which is the more economical system in any given case, referring to data given in a recent paper before the Inst. of Elec. Engrs. 3000 w. Engng—Feb. 26, 1909. No. 3068 A.

The Electrical Equipment of Messrs. Selfridge & Co.'s New Building in Oxford Street, London. Illustrated description of the details for electric lighting and power in a modern department store. 5500 w. Elect'n, Lond—March 5, 1909. No. 3153 A.

**Operation.**

Flywheel Load Equalizer. J. S. Peck. Abstract of a paper read before the Manchester Sec. of the Inst. of Elec. Engrs. Discusses the use of flywheels as equalizers of the load on generating stations, and describes arrangements for d. c. and a. c. circuits. 2000 w. Elect'n, Lond—Feb. 26, 1909. No. 3053 A.

**Rates.**

Systems of Charging for Electrical Energy. W. T. Ryan. A comparison of nine principal methods. 3500 w. Engineering Magazine—April, 1909. No. 3525 B.

Supply by Meter, or Contract? W. A. Toppin. Discusses the two systems and the prevention of fraud. 1200 w. Elec Rev, Lond—March 5, 1909. No. 3149 A.

**Switchboards.**

Notes on Switchboard Instruments. H. W. Richardson. Remarks on inspection, testing, hot wire instruments, etc. 4000 w. Elec Age—March, 1909. No. 3217.

Guide to Small Station Switchboard Design. General instructions and suggestions to station managers for laying out switchboards for small alternating and direct current plants. Diagrams. 3000 w. Power—March 9, 1909. No. 3038.

High-Tension Equipment and Control of Waterside Station No. 2 of the New York Edison Company. Illustrated detailed description of the high-tension control board. 1600 w. Elec Wld—March 25, 1909. No. 3510.

## LIGHTING.

**Illumination.**

The Province of the Illuminating Engineer. Leon Gaster. Considers some of the more important problems in artificial lighting. 4500 w. Pub Works—Oct.-Dec., 1908. No. 3591 B.

The Problem of Efficiency in Illumination. Arthur J. Sweet. Considers the conditions on which it depends. 3500 w. Elec Jour—March, 1909. No. 3202.

The Bearing of Modern Illumination Upon Physiological Optics. Sydney A. Ashe. A discussion of some of the relations of illumination to vision, particularly the relation of light-quality to visual acuity. Also editorial. 4000 w. Elec Wld—Feb. 25, 1909. No. 2871.

**Incandescent Lamps.**

Series Tungsten Lighting. Henry Schroeder. Abstract of a paper before the N.-W. Elec. Assn. Explains the advantages of tungsten lamps. 1800 w. Elec Rev, N Y—Feb. 27, 1909. No. 2856.

Radiation Constants of Metals. W. W. Coblentz. An investigation made to obtain some estimate of the emissivity of incandescent metal filaments. 11500 w. Bul Bureau of Stand—Feb., 1909. No. 3285 N.

Results of Tests on Metallic-Filament Lamps at the Laboratoire Central d'Electricité (Résultats d'Essais effectués au Laboratoire central d'Electricité sur les Lampes a Filament metallique). F. La-

porte. Results of various tests on nine types of metallic-filament lamp in use in Paris. Ills. 5200 w. Bul Soc Int d' Elecns—Feb., 1909. No. 3305 F.

The Actual Status of Metallic Filament Lamps (Etat actuel des Lampes à Incandescence à Filaments métalliques). A. Blondel. Reviews their history, the difficulties of their manufacture, their properties and the results obtained from their use. Ills. 10800 w. Bul Soc Int d'Elecns —Feb., 1909. No. 3304 F.

**Photometry.**

See Meters, under MEASUREMENT.

**Street.**

Some Principles of Street Illumination. Dr. Louis Bell. 2500 w. Elec Rev, N Y —March 13, 1909. No. 3129.

## MEASUREMENT.

**Dynamo Testing.**

The Kapp-Hopkinson Test on a Single Direct-Current Machine. Dr. W. Lulofs. Read before the Birmingham Sec. of the Inst. of Elec. Engrs. Shows how this test may be adapted on a single lap-wound d. c. machine, provided it is not supplied with Mordey equalizing connections. 3000 w. Elec Engr, Lond—Feb. 26, 1909. Serial. 1st part. No. 3050 A.

**Hysteresis.**

Errors in Magnetic Testing with Ring Specimens. Morton G. Lloyd. The methods of determining the hysteresis of a ring specimen are considered and the energy losses calculated. 2500 w. Bul Bureau of Stand—Feb., 1909. No. 3288 N.

**Inductance.**

A Simple Means of Measuring Inductances. C. J. Watson. Describes apparatus consisting of a kind of Wheatstone bridge in which two inductances are balanced against two capacities. 1000 w. Elect'n, Lond—March 5, 1909. No. 3154 A.

**Instruments.**

Electrical Measuring Instruments and Some of Their Weaknesses. Kenelm Edgcumbe. Discusses points to be considered in selecting an instrument, the question of accuracy, etc. 5500 w. Pub Works—Oct.-Dec., 1908. No. 3593 B.

See also Switchboards, under GENERATING STATIONS.

**Meters.**

A Volt Scale for a Watts-Per-Candle Meter. Herbert E. Ives. Describes a method of applying a direct-reading scale to a specific consumption photometer. 1500 w. Elec Wld—March 25, 1909. No. 3512.

**Stray Flux.**

The Determination of Stray Flux in Alternating-Current Windings (Beitrag zur Bestimmung der Streuung von Wechselstromwicklungen). M. Schenkel. Describes and discusses mathematically a method of measurement. Ills. 5200 w. Elektrotech u Maschinenbau—Feb. 28, 1909. No. 3558 D.

**Units.**

Remarks on the Systems of Units (Remarques sur les Systèmes d'Unités). D. Berthelot. Principally a discussion of M. Brylinski's paper. 7400 w. Bul Soc Int d'Elecns—Feb., 1909. No. 3303 F.

## POWER APPLICATIONS.

**Cranes.**

See Crane Trolleys, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

## TRANSMISSION.

**Direct Current.**

Direct-Current Transmission on the Thury System (La Trasmissione dell' Energia elettrica col Sistema Thury a Corrente continua). Salvatore Spera. Discusses the Thury system under the heads, cost, economy and continuity of service. Serial. 1st part. 4000 w. Industria—Feb. 21, 1909. No. 3353 D.

**High Tension.**

Notes on Transmission Practice in the Northwest. Magnus T. Crawford. Read at meeting of the Seattle Sec. of the Am. Inst. of Elec. Engrs. Describes the systems of high-tension transmission in the Pacific Northwest, discussing their merits and defects. 4500 w. Pro Am Inst of Elec Engrs—March, 1909. No. 3475 F.

**Insulators.**

An Investigation as to the Cause of Breakage in Service of Certain High Tension Glass Insulators. Albert S. Richey and Frederick Bonnet, Jr. Shows the value of polarized light in examining glass insulators. 2500 w. Jour Worcester Poly Inst—March, 1909. No. 3448 C.

Condenser Type of Insulation for High-Tension Terminals. A. B. Reynders. Explains the difficulties of this problem, and describes the mechanical design of this type of insulated terminal, explaining the principles. Ills. 2000 w. Pro Am Inst of Elec Engrs—March, 1909. No. 3478 F.

**Lightning.**

See Atmospheric Electricity, under MISCELLANY.

**Lightning Arresters.**

See Signalling, under RAILWAY ENGINEERING, CONDUCTING TRANSPORTATION.

**Line Construction.**

See Telegraph Lines, under COMMUNICATION.

**Line Design.**

A Quick Method for Determining Sags and Tensions in Transmission Lines. H. J. Glaubitz. Describes an analytical method which is quicker than the graphical method usually employed. 1000 w. Elec Wld—March 25, 1909. No. 3511.

*We supply copies of these articles. See page 319.*

Extending the Limits of Power Transmission—As Applied Both to Long Distance Transmission of Power and to Power Companies' areas. A. M. Taylor. Read before the Birmingham Sec. of the Inst. of Elec. Engrs. Suggests possibilities in the way of commercial developments, considering overhead and underground lines. 3000 w. Elec Engr, Lond—March 12, 1909. No. 3402 A.

**Protective Devices.**

The Protection of Low-Pressure Circuits. Gisbert Kapp. Abstract trans. from *Elektrotechnische Zeit.* Describes a safety device which can be adjusted to switch out automatically. 1200 w. Elect'n, London—March 19, 1909. No. 3603 A.

The Protection of Lines Against Surge Tensions and Atmospheric Discharges. Discusses means of effecting a complete protection of the distribution system. 2500 w. Elect'n, Lond—Feb. 26, 1909. No. 3055 A.

See also Transformers, under TRANSMISSION.

**Reactive Coils.**

Air-Blast Reactances. R. E. Scott. Points out a consideration that should be taken into account in judging the size from the rating, or the rating from the size. Ills. 1000 w. Harvard Engng Jour—Jan., 1909. No. 3195 D.

**Regulations.**

Transmission Line Railway Crossings (Le Norme per gli Attraversamenti delle Ferrovie con Condutture elettriche). Gives the regulations of the Italian Railway Department. Ills. 3000 w. Ing Ferro—Feb. 1, 1909. No. 3354 D.

**Transformers.**

Transformation Wrinkles. H. B. Gear and P. F. Williams. Explains various applications of the booster, and devices useful under certain conditions. Diagrams. 3500 w. Elec Age—March, 1909. No. 3216.

High Voltage Transformers and Protective and Controlling Apparatus for Outdoor Installation. K. C. Randall. Discusses the design and construction of outdoor apparatus, considering the application. Ills. 3000 w. Pro Am Inst of Elec Engrs—March, 1909. No. 3479 F.

The Design of Transformers With Minimum Cost for Materials (Berechnung von Transformatoren auf den Mindestbetrag an Kosten des wirksamen Materials). J. T. Duyvis. Mathematical discussion of the Pohl and Bohle method. Ills. 3200 w. Elektrotech u Maschinenbau—Feb. 14, 1909. No. 3556 D.

The Distribution of Heat in an Annular Plate (Die Verteilung der Beharrungstemperatur in einer kreisringförmigen Platte). Fritz Emde. A mathematical paper in amplification of the article by Karl Kohler. Ills. 3200 w. Elektrotech u Maschinenbau—Feb. 21, 1909. No. 3557 D.

**Voltage Regulation.**

Discussion on "Conditions Affecting Stability in Electric Lighting Circuits." New York, Jan. 8, 1909. Gives the discussion on Elihu Thompson's paper. 8000 w. Pro Am Inst of Elec Engrs—March, 1909. No. 3480 F.

The Thury Automatic Regulator (Régulateurs automatiques Système R. Thury). Describes its construction, operation, regulation, and applications. Ills. 3000 w. Bul Tech d l Suisse Rom—Feb. 25, 1909. No. 3336 D.

# INDUSTRIAL ECONOMY

**Accounting.**

Machine Accounting in Machine-Tool Building. Describes the use of the tabulating machine in the cost accounting department of the Bullard Machine Tool Co. 2800 w. Am Mach—Vol. 32. No. 11. No. 3219.

Inventory Books for Real Estate, Buildings, Tools, Patterns and Furniture (Inventarienbücher für Grundstücke, Gebäude, Werkzeuge, Modelle, und Mobiliar). C. M. Lewin. Illustrates and describes satisfactory types. Serial. 1st part. 2400 w. Zeitschr f Werkzeug—Feb. 25, 1909. No. 3386 D.

**Education.**

The Practical Training of Mechanical Engineers. Franz zur Nedden. A comparison of German, English and American methods. 2500 w. Engineering Magazine—April, 1909. No. 3527 B.

The Scientific Spirit and Education (L' Esprit scientifique et l'Enseignement). Paul Appel. Discusses the condition of scientific education in France. 3300 w. L'Elecn—Feb. 6, 1909. No. 3331 D.

The Hammond Mining and Metallurgical Laboratory of the Sheffield Scientific School, Yale University. Louis D. Huntoon. Illustrated detailed description of the building and its equipment. 4000 w. Bul Am Inst of Min Engrs—March, 1909. No. 3468 F.

**Engineering.**

The Place of the Engineer in Public Life (Die Stellung des Ingenieurs im öffentlichen Leben). C. Buschkiel. A discussion of the relations of the engineer

with the public. 7000 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1909. No. 3570 D.

**Engineering Societies.**

The Engineer and the People. Discussion of Morris L. Cooke's paper on this subject. 7800 w. Jour Am Soc of Mech Engrs—March, 1909. No. 3463 F.

**Filing Systems.**

Card Systems in Engineering Works. Alfred B. Searle. The present number explains the object of card systems. 1500 w. Mech Wld—March 5, 1909. Serial. 1st part. No. 3157 A.

**Management.**

Some Suggestions of Reform in Engineering Practice. J. E. Livermore. Suggestions for improvement in manufactories and commerce. 5000 w. Cassier's Mag—March, 1909. Serial. 1st part. No. 2926 B.

See also Shops, under MECHANICAL ENGINEERING, MACHINE WORKS AND FOUNDRIES; and Management, under RAILWAY ENGINEERING, MISCELLANY.

**Natural Resources.**

The New Union Among the States. W. J. McGee. Discusses the movements for the conservation of the natural resources of the United States, and the interdependence of the states in the work. 3000 w. Am Rev of Revs—March, 1909. No. 2917 C.

The North American Conference on the Conservation of Natural Resources. Gives the "Declaration of Principles" adopted, with introductory statement. 2500 w. Eng News—March 4, 1909. No. 3000.

**Patents.**

Making Inventions and Getting Patents. John D. Morgan. A statement of facts in regard to the patent situation, and a discussion of improvements needed. 1200 w. Ir Trd Rev—March 18, 1909. Serial. 1st part. No. 3233.

A Phase of the Patent Situation. James T. Barkelew. Suggests the adoption of a system of taxation, or compulsory working, or both, to correct the unfavorable conditions now existing. 2500 w. Elec Wld—March 18, 1909. No. 3227.

**Public Utilities.**

Equitable Rate-Making by Public Service Companies. Dugald C. Jackson. A discussion of the problems of appropriately fixing rates, and the test of their equitableness. 10500 w. Tech Qr—Dec., 1908. No. 3439 E.

**Stores Keeping.**

See Management, under RAILWAY ENGINEERING, MISCELLANY.

**Tariff.**

The Payne Tariff Bill. Text of the metal schedule of the tariff bill introduced in the House of Representatives, March 17, 1909. 6000 w. Ir Age—March 18, 1909. No. 3212.

Iron and Steel Duties in the Payne Tariff Bill. Discusses the significance of the more important changes. 3000 w. Ir Age—March 25, 1909. No. 3484.

**Wage Systems.**

The Advantage of the Bonus System and Suggestions to Contractors Who Contemplate Applying It. 1200 w. Engng-Con—March 17, 1909. No. 3234.

## MARINE AND NAVAL ENGINEERING

**Barges.**

Reinforced Concrete Barges and Pontoons (Chalands et Pontons en Ciment armé). E. Lemaire. Describes boats of reinforced concrete built on the Tiber. Ills. 3000 w. Génie Civil—Feb. 6, 1909. No. 3337 D.

**Battleships.**

Requisites of the Battleship Best Adapted to the Italian Navy and Consideration of Its Tactical Employment. Romeo Bernotti. Examines the desirable and possible requisites, describing the type of battleship and studying its employment. Ills. 2800 w. Pro U S Naval Inst—March, 1909. No. 3549 F.

The Launch of H. M. S. "Vanguard." Illustrations and information concerning this vessel, the seventh battleship of the Dreadnought class. 2500 w. Engng—Feb. 26, 1909. No. 3069 A.

**British Navy.**

The Future of Naval Engineering. Editorial discussion of the present situation in the British navy, with the statement of the case as prepared for circulation to Members of Parliament. 4000 w. Engng—March 12, 1909. No. 3419 A.

The Navy Estimates. A review of the proposals, with editorial review of the debate in Parliament. 6000 w. Engng—March 19, 1909. No. 3617 A.

**Destroyers.**

Torpedo-Boat-Destroyers for the Brazilian Navy. Plate and illustrated detailed description of these vessels. 2500 w. Engng—March 12, 1909. No. 3418 A.

**Dockyard Administration.**

Dockyard Administration. A survey of the present administrative organization of the Royal Dockyards. 2500 w. Engr, Lond—Feb. 19, 1909. No. 2899 A.

*We supply copies of these articles. See page 319.*

**Electric Power.**

The Electrical Equipment of Liners and Battleships. A. P. Chalkley. Read before the Newcastle-on-Tyne Sec. of the Inst. of Elec. Engrs. Discusses the systems and applications made of electricity on shipboard. 5500 w. Elec Engr, Lond—March 19, 1909. No. 3601 A.

**Ferryboats.**

Steam Car Ferries on the Great Northwestern Lakes. Illustrated description of recent types. 3000 w. Naut Gaz—Feb. 25, 1909. No. 2865.

**Gas Engines.**

Gas-Driven Battleships and Cruisers. Reviews what has been done in applying producer-gas engines to the propulsion of warships, and the advantages of gas power. Ills. 1500 w. Sci Am—March 13, 1909. No. 3131.

See also Motor Boats, under MARINE AND NAVAL ENGINEERING.

**Gasolene Engines.**

See Yachts, under MARINE AND NAVAL ENGINEERING.

**Hospital Ships.**

Boston Floating Hospital. Illustrated description of a vessel equipped with the indirect system of refrigeration and ventilation. 1200 w. Ice & Refrig—March, 1909. No. 3022 C.

**Hydroplanes.**

"Hydroplanes" or "Skimmers." Sir John I. Thornycroft. Deals with boats which at high speeds are heavier than the water they displace. 2200 w. Engng—March 12, 1909. No. 3421 A.

The Hydroplane Ship. From *Shipping Gazette.* Brief account of early experiments and modern developments. 1500 w. Marine Rev—March 4, 1909. No. 3009.

**Internal-Combustion Engines.**

The Propulsion of Ships by Internal-Combustion Engines. F. DeKeyser, in the *Ship Builder.* An illustrated review of what has been accomplished. 2500 w. Marine Rev—March 4, 1909. No. 3010.

**Lifeboats.**

The Strength of Wooden Ship's Boats (Festigkeit hölzerner Schiffsbeiboote). J. Stieghorst. A discussion of their design for strength and safety. Ills. Serial. 1st part. 4000 w. Schiffbau—Feb. 10, 1909. No. 3374 D.

**Model Basins.**

The Value of the Model Experimental Basin in Ship Designing. Robert G. Skerrett. Considers the objects of a model basin and gives an illustrated description of the work at the testing tank of the Washington Navy Yard. 6000 w. Cassier's Mag—March, 1909. No. 2924 B.

Theory of the Wellenkamp Towing Method (Theorie des Schleppverfahrens nach Methode Wellenkamp). Herr Rothe. A comparison with the Froude method and an elaborate mathematical discussion. Ills. Serial. 1st part. 4200 w. Schiffbau—Feb. 24, 1909. No. 3376 D.

**Motor Boats.**

The Motor Boat Marenging. Illustrated description of a boat propelled by a producer gas plant, being built at St. Joseph, Mich. 2000 w. Int Marine Engng—March, 1909. No. 3015 C.

**Propellers.**

The Villinger Reversible Propeller. Illustrated description of a design that appears to be a practical success. 1200 w. Engng—Feb. 26, 1909. No. 3066 A.

**Review of 1908.**

Scotch Shipbuilding in 1908. Benjamin Taylor. A review. 2500 w. Int Marine Engng—March, 1909. No. 3014 C.

**Safety Devices.**

Safety of Travel on the Modern Ocean Liner. E. A. Stevens. An illustrated account of important safeguards to human life recently fitted to ships. 2500 w. Am Rev of Revs—March, 1909. No. 2918 C.

**Ship Design.**

Modern Ship Design. Leslie Denny. Read before the Manchester Assn. of Engrs. Explains how the first rough estimate for a ship is prepared, the design being more fully worked out in the drawing office. 2500 w. Mech Engr—March 5, 1909. No. 3155 A.

Water-Tight Bulkheads in Passenger Vessels. A review of present practice in designing and locating bulkheads. 2500 w. Engr, Lond—Feb. 26, 1909. No. 3072 A.

Longitudinally Framed Ships. Illustrated detailed description of the "Craster Hall," a vessel built on the Isherwood system, with modifications. 5000 w. Engr, Lond—March 5, 1909. No. 3175 A.

**Ship Lighting.**

See Ship Ventilation, under MARINE AND NAVAL ENGINEERING.

**Ship Ventilation.**

Lighting and Ventilation of Inside Cabins (Ueber Beleuchtung und Ventilation von Innenkammern). R. Schmidt. Brief description of methods. Ills. 1300 w. Schiffbau—Feb. 10, 1909. No. 3375 D.

**Spanish Navy.**

The New Spanish Navy. Editorial on the scheme laid out for the reinstatement of Spain among the naval powers of Europe. 2500 w. Engng—March 5, 1909. No. 3168 A.

**Steamboats.**

Launch of Magnificent New Hudson River Steamboat, Robert Fulton. Illustration, with interesting details of a vessel built in record time. 1200 w. Naut Gaz—March 25, 1909. No. 3503.

United States Life-Saving Steamer,

*We supply copies of these articles. See page 319.*

"Snohomish." Illustrated description of a vessel designed and equipped for life-saving under difficult conditions. 1300 w. Sci Am—March 6, 1909. No. 2969.

**Steam Boilers.**

Gunboat Boilers. Charles S. Linch. Illustrates and describes the low high-pressure boilers in the Wilson Line boats on the Delaware River. 2000 w. Int Marine Engng—March, 1909. No. 3013 C.

**Steam Engines.**

See Torsionmeters, under MECHANICAL ENGINEERING, MEASUREMENT; and Valve Gears, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

**Steamships.**

The Hamburg-American Line Steamer Cleveland. Illustrated description. 3500 w. Int Marine Engng—March, 1909. No. 3011 C.

The Japanese Volunteer Turbine Steamer "Sakura Maru." Illustrated description. 1800 w. Engng—March 5, 1909. No. 3172 A.

**Steam Turbines.**

Steam Turbines in the Navy. On the advantages of turbines, their manipulation and care. 2500 w. Mech Wld—Feb. 19, 1909. Serial. 1st part. No. 2886 A.

**Steering Gear.**

The Steering of the Ship. A study of steering gear and its operation. 3500 w. Marine Rev—March 4, 1909. No. 3008.

**Torpedo Boats.**

A New Type of Torpedo Boat. Hudson Maxim. Read before the Am. Chem. Soc. Describes a proposed design for a submersible torpedo boat with a destructible bow. Ills. 2000 w. Int Marine Engng—March, 1909. No. 3012 C.

**U. S. Navy.**

Amateur Reorganization in the United States Navy. Criticism of recent changes, especially discussing the effect in navy yards. 4000 w. Engineering Magazine—April, 1909. No. 3522 B.

The Reorganization of the Naval Establishment. J. A. Mudd. Discusses the proper place of the industrial and commercial forces in any reorganization scheme. 11500 w. Pro U S Naval Inst—March, 1909. No. 3548 F.

**Yachts.**

Taniwha—112 ft. Twin Screw Gasolene Propelled Private Yacht. Illustrated description. 800 w. Naut Gaz—March 18, 1909. No. 3259.

# MECHANICAL ENGINEERING

## AUTOMOBILES.

**Armstrong-Whitworth**

The 18-22-H.P. Armstrong-Whitworth Car. Illustrated detailed description of the latest model of these cars. 1200 w. Auto Jour—March 20, 1909. No. 3596 A.

**Austin.**

Austin Pullman Landaulet. Illustrations with brief description of an entirely enclosed car. 300 w. Autocar—March 20, 1909. No. 3600 A.

**Axles.**

The Section of Fixed Axles for Motor Cars. Compares the advantages of the various sections now used, studying the stresses. 1500 w. Engng—March 5, 1909. No. 3163 A.

**Brakes.**

The Pulling-Up Powers of a Car. Reports some actual tests with the brakes of modern motor vehicles. Ills. 1600 w. Auto Jour—Feb. 20, 1909. Serial. 1st part. No. 2873 A.

**Darracq.**

The 14-H.P. Darracq Car. Illustrated description. 800 w. Auto Jour—March 13, 1909. No. 3433 A.

**Design.**

Improved Forms of the Buggy Type Automobile. Illustrates and describes types of motor buggies and their power plants. 2000 w. Sci Am—March 20, 1909. No. 3246.

**Electric.**

The Mileage Radius of Electric Vehicles. Frank B. Rae. Considers the determining factors. 1800 w. Elec Rev, N Y March 6, 1909. No. 3006.

**Gasoline Meters.**

The Smith Petrol Meter. Illustrated description of a valuable accessory for a motor car. 2000 w. Auto Jour—March 6, 1909. No. 3146 A.

**Gears.**

Differential Gears for Motor-Cars. A critical discussion of the types in general use. Ills. 1600 w. Engng—Feb. 26, 1909. No. 3063 A.

**Laurin-Klement.**

Three Laurin and Klement 1909 Models. Brief illustrated descriptions of the 14-16 h.p., 10-12 h.p., and 10 h.p. cars. 900 w. Autocar—March 6, 1909. No. 3148 A.

**Lighting.**

Economy Results from Understanding Acetylene. Discusses phases of lighting by means of acetylene, with particular reference to calcium carbide. Ills. 2500 w. Automobile—March 25, 1909. No. 3504.

*We supply copies of these articles. See page 319.*

**Lubrication.**

Lubrication. J. W. G. Brooker. Abstract of paper considering points on lubrication. 2200 w. Auto Jour—March 6, 1909. Serial. 1st part. No. 3147 A.

**Motor Control.**

A Few Observations on Engine Control. A study of various systems. Ills. 1500 w. Autocar—Feb. 20, 1909. No. 2874 A.

**Motor Power.**

Increasing Motor Power per Unit of Mass. G. Lumet. Reviews the factors that increase the mechanical efficiency of a motor. 2000 w. Automobile—March 4, 1909. No. 2967.

**Motors.**

Bore and Stroke. Discusses the pros and cons of long and short strokes. 1800 w. Autocar—March 20, 1909. No. 3599 A.

See also Benzine Motors, under COMBUSTION MOTORS; and Shop Practice, under MACHINE WORKS AND FOUNDRIES.

**N. A.-G.**

Cars of the Neue Automobil-Gesellschaft (Die Personenwagen der Neuen Automobil-Gesellschaft). O. Winkler. Describes novel features of the 25-36 h.p. car. Ills. 2200 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1909. No. 3563 D.

**Omnibuses.**

Motor Passenger-Vehicles. J. F. Gairns. Illustrates and describes recent developments in motor omnibuses, and some of their uses. 5000 w. Cassier's Mag—March, 1909. No. 2923 B.

**Selden.**

What Is the Selden Patent? Charles B. Haywood. An explanation, with illustrated descriptions of types of Selden cars. 2500 w. Sci Am—March 20, 1909. No. 3248.

**Springs.**

Springs (Des Resorts). M. Marcheseau. Mathematical discussion of the design of automobile springs. 2300 w. All Indus—Feb., 1909. No. 3327 D.

**Steering Gears.**

Safety and Utility of Automobile Steering Systems. Thomas J. Fay. An examination of the various systems. Ills. 2000 w. Automobile—March 11, 1909. Serial. 1st part. No. 3089.

**Tires.**

The Hall and Baynes Detachable Rim. Illustrated description of a device for facilitating speedy tire changes. 700 w. Autocar—March 13, 1909. No. 3401 A.

**Traction Engines.**

A Gasoline Caterpillar Traction Engine. Brief illustrated description of engines operating on the Mojave desert in connection with work on the Los Angeles aqueduct and reservoir system. 1000 w. Sci Am Sup—March 6, 1909. No. 3577.

**Tractors.**

The War Office Tractor Trials. Illustrates and describes the three vehicles that competed on March 1st. 4000 w. Engr, Lond—March 5, 1909. No. 3177 A.

Military Tractor Trials. Reports on the British War Office trials, giving particulars of vehicles entered. 1200 w. Engng—March 5, 1909. Serial. 1st part. No. 3169 A.

The Thornycroft Tractor. Illustrated description of the vehicle entered for the War Office trials. 600 w. Engng—March 5, 1909. No. 3171 A.

Lessons from the Trials of Military Tractors. Editorial on the recently completed War Office trials. 3000 w. Engng—March 19, 1909. No. 3620 A.

**Vulcan.**

The 16 h.p. Vulcan Car. Brief illustrated description of a car of moderate power. 1000 w. Autocar—Feb. 20, 1909. No. 2875 A.

## COMBUSTION MOTORS.

**Benzine Motors.**

The Working Cycle in Automobile Motors (Untersuchung des Arbeitsprozesses im Fahrzeugmotor). Kurt Neumann. Describes and gives the results of an elaborate research on a one-cylinder de-Dion-Bouton benzine motor. Ills. Serial, 1st part. 4400 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1909. No. 3572 D.

**Gas Cleaning.**

See Blast-Furnace Gas, under MINING AND METALLURGY, IRON AND STEEL.

**Gas Engines.**

Westinghouse Gas Engines at Gary. Illustrates and describes the mechanical and operative features of the No. 3 gas-driven blowing plant of the Indiana Steel Co. 6000 w. Ir Age—March 4, 1909. No. 2930.

Large Gas Engines (Les Moteurs à Gaz de grandes Puissances). M. L. Letombe. Discusses their design, the various types, their application, etc. Ills. 1800 w. Mem Soc Ing Civ de France—Dec., 1908. No. 3302 G.

See also Gas vs. Steam, under POWER AND TRANSMISSION.

**Gas Power Plants.**

Municipal Producer Gas Plants at Peru, Ind. Osborn Monnett. Illustrated description of a plant supplanting a steam-engine plant and showing reduced consumption. 1500 w. Power—March 16, 1909. No. 3186.

The Boston Elevated Railway Company's Recent Gas Engine Experience. H. S. Knowlton. A review of the performance of the gas-engine station at Somerville, Mass., comparing it with the steam plant at East Boston. 2000 w. Eng Rec—March 27, 1909. No. 3541.

*We supply copies of these articles. See page 319.*

**Gas Producers.**

Producer Gas. With Special Reference to Suction Gas Producers for Power. Lawrence P. Tolman. Reviews the history and development, efficiency, testing, etc. Ills. 4000 w. Jour Worcester Poly Inst—March, 1909. No. 3447 C.

The Construction and Management of Gas Producers for Open-hearth Steel Works. C. Canaris. Trans. from *Stahl und Eisen*. Considers the more important points in the construction and management of gas producers, discusses types, and favors the proved types of rotary grate gas producers. 4500 w. Ir & Coal Trds Rev—March 12, 1909. No. 3430 A.

**Ignition.**

Ignition. J. A. Williams. Read before the Nat. Gas & Gasoline Eng. Trds. Assn. Also discussion. Discusses the make and break and jump spark systems. 7000 w. Gas Engine—March, 1909. No. 3190.

**Oil Engines.**

Junkers' Two-Cycle Oil Engine. Illustrated description of the engine and its operation. 800 w. Mech Engr—Feb. 26, 1909. No. 3059 A.

**Power.**

*A priori* Determination of the Power of an Explosion Motor (Détermination *"à priori"* de la Puissance des Moteurs à Explosion). E. Girardault. A critical mathematical discussion of various formulae proposed. Ills. 2400 w. Génie Civil—Feb. 20, 1909. No. 3345 D.

## HEATING AND COOLING.

**Central Plants.**

Central Heating Plant for Lebanon, Ind. Byron T. Gifford. Illustrated description of a central hot-water system. 1200 w. Power—March 2, 1909. No. 2906.

**Cooling Towers.**

Cooling-Tower Practice. J. H. Hart. Information in regard to both the open and closed types, their efficiency, etc. 2000 w. Elec Wld—March 4, 1909. No. 2992.

**Experimental Apparatus.**

Glass Experimental Apparatus (Eine Glasheizung für Versuchszwecke). Max Hottinger. Describes apparatus devised for studying hot-water heating phenomena, with results of tests. Ills. 4000 w. Gesundheits-Ing—Feb. 13, 1909. No. 3389 D.

**Hospital Heating.**

Some Methods of Heating Adopted in Hospitals and Asylums Recently Built. Ernest Richard Dolby. Illustrates and describes heating and hot-water service systems designed for conditions in England. Discussion. 22500 w. Inst of Civ Engrs—No. 3687. No. 3209 N.

**Hot-Air Heating.**

Design of Furnace Heating Systems, with an Application to a Ten-Room Residence. J. D. Hoffman. Detailed discussion of necessary calculations. 4500 w. Heat & Vent Mag—March, 1909. Serial. 1st part. No. 3453.

**Hot-Water Heating.**

Local Regulation of Hot-Water Heating (Die örtliche Regelung der Warmwasserheizung). Anton Gramberg. Mathematical discussion. Ills. Serial. 1st part. 6000 w. Gesundheits-Ing—Feb. 6, 1909. No. 3388 D.

See also Central Plants and Experimental Apparatus, under HEATING AND COOLING.

**Indirect Heating.**

A Rational Formula Covering the Performance of Indirect Heating Surface. Perry West. Part of a discussion before the Am. Soc. of Heat. & Vent. Engrs. Explains the theory on which the formula is based. 1300 w. Heat & Vent Mag—March, 1909. No. 3451.

**Refrigeration.**

Wet versus Dry Compression. Joseph H. Hart. Explains the meaning of the terms and the factors that determine the efficiency of the two types. 2500 w. Power—March 9, 1909. No. 3041.

Calcium Chloride versus Salt. L. E. Diamond. Read at the Indiana Ice Mfrs. Con. Discusses their value and economy as refrigerating agents. 3000 w. Ice & Refrig—March, 1909. No. 3023 C.

The Problem of the Small Refrigerating Machine. Sterling H. Bunnell. Discusses practical conditions attending refrigeration on a small scale. 2000 w. Cassier's Mag—March, 1909. No. 2922 B.

See also Hospital Ships, under MARINE AND NAVAL ENGINEERING.

**Steam Heating.**

Heating and Ventilation of the Hotel Plaza, New York; Part I. An 18-story hotel of 800 guest rooms, having one of the finest mechanical equipments ever installed. Plans and description. 5500 w. Eng Rec—March 13, 1909. Serial. 1st part. No. 3113.

**Temperature Regulation.**

See Hot-Water Heating, under HEATING AND COOLING.

## HYDRAULIC MACHINERY.

**Air Lift.**

Tests Upon Compressed Air Pumping Systems of Oil Wells. Edmund M. Ivens. Description of systems and report of tests. 3500 w. Jour Am Soc of Mech Engrs—March, 1909. No. 3462 F.

**Centrifugal Pumps.**

Design of a Centrifugal Pump. A detailed study. Ills. 1500 w. Prac Engr—Feb. 19, 1909. Serial. 1st part. No. 2880 A.

Characteristics of the Turbine Pump. Frederick Ray. A study of the design

and operation of centrifugal pumps by means of curves. 5000 w. Power—March 23, 1909. No. 3437.

Operating and Test Results of Schwartzkopff High-Lift Centrifugal Pumps (Ausführungen und Versuchsresultate von Hochdruckzentrifugalpumpen der Berliner Maschinenbau-Aktiengesellschaft vormals L. Schwartzkopff). Herr Griessmann. Description of the pumps and tests and tabulated results. Ills. Serial. 1st part. 1600 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 20, 1909. No. 3380 D.

**Electric Pumping.**

Electrically-Operated Pumping and Air-Compressing Installation at Messrs. Harland & Wolff's Shipbuilding Yard, Belfast. Brief illustrated description. 3000 w. Elect'n, Lond—Feb. 26, 1909. No. 3054 A.

**Experimental Apparatus.**

An Experimental Hydraulic Cylinder. E. G. Coker. Illustrated description of a cylinder hung vertically, so that the lower face would be available for vertical jets, and be entirely free of supports. 1000 w. Engng—March 19, 1909. No. 3616 A.

**Pumping Plants.**

A Power Plant for Rice Irrigation. John W. Maxcy. Brief description of a plant near Wharton, Texas. Ills. 700 w. Eng Rec—March 20, 1909. No. 3274.

See also Water Wheels, under HYDRAULICS.

**Turbines.**

Brake Tests on a Lorenz Turbine (Bremsergebnisse einer Lorenzturbine). Robert Goldschmidt. Describes the machine and tests, and discusses the results. Ills. Serial, 1st part. 2000 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 20, 1909. No. 3379 D.

**Water Wheels.**

Power from the Current of the River Clutha (N. Z.). Frank Reed. Description of wheel pumping plants, utilizing a river having a velocity varying from 5 to 8 miles per hour. Ills. 1500 w. Aust Min Stand—Feb. 17, 1909. No. 3588 B.

**Wave Motor.**

The Snee Wave Motor and Its Possibilities. Franklin Van Winkle. Illustrated description of a turbine construction designed to utilize the energy of ocean waves and currents to develop power. 4500 w. Power—March 2, 1909. No. 2905.

## MACHINE ELEMENTS AND DESIGN.

**Ball Bearings.**

See Testing Machines, under MEASUREMENT.

**Bearings.**

Ring-Oiled Conical-Seated Bearings for Machine Tools. Discusses bearings for high-speed tools and means by which they could be improved. 1500 w. Mech Wld—March 5, 1909. No. 3156 A.

**Crank Shafts.**

The Influence of the Angles of a Crank Shaft on its Deformation (Ueber den Einfluss der Kröpfungsecken auf die Formänderung von gekröpften Kurbwellen). Eugen Meyer. Mathematical discussion of the stresses in crank-shaft angles. Ills. 2800 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1909. No. 3568 D.

**Gears.**

A Discussion of Involute-Spur and Helical Gearing. Frank Burgess. Considers the requirements and some problems not yet solved. 1000 w. Am Mach—Vol. 32. No. 9. No. 2936.

The Strength of Raw Hide Gearing. R. Livingstone. Considers methods of calculating the size of pinion required for a given power and speed. 1500 w. Elect'n, Lond—March 19, 1909. No. 3604 A.

**Kinematics.**

The Graphical Design of the Slot and Crank (Der graphische Entwurf der Kurbelschleife). Hans Volkmann. Illustrated mathematical discussion. 2000 w. Zeitschr f Werkzeug—Feb. 15, 1909. No. 3385 D.

**Milling Machines.**

Cutter-Marks. H. S. Quackenbush. Explains means of facilitating calculations in designing a mill or milling machine so that the depth of these waves will be small. 2000 w. Harvard Engng Jour—Jan, 1909. No. 3196 D.

**Presses.**

A Note on the Design of Flywheel Presses (Ein Beitrag zur Berechnung der Schwungradpressen). Herr Schlesinger. Mathematical discussion of the design of presses for sheet-metal work. Ills. 7100 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1909. No. 3567 D.

**Strength of Materials.**

The Strength of Pipes and Cylinders. C. A. Smith. Shows how the new interpretation of Guest's law affects the theory of tubes and thick cylinders. 1000 w. Engng—March 5, 1909. No. 3170 A.

## MACHINE WORKS AND FOUNDRIES.

**Automatic Machines.**

See Lathes, under MACHINE WORKS AND FOUNDRIES.

**Bending Machines.**

The Caskey Hydro-Pneumatic Bending Machine. C. M. Hamersly. Illustrated description. 800 w. Am Mach—Vol. 32. No. 12. No. 3488.

**Brass Founding.**

The Economy of Skimming Brass Into Water. A. L. Haasis. Describes the Metal Dross Economy process, and the saving effected. 1000 w. Brass Wld—March, 1909. No. 3443.

See also Alloys, under MACHINE WORKS AND FOUNDRIES.

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**Brazing.**

See Welding, under MACHINE WORKS AND FOUNDRIES.

**Castings.**

Interesting Tests of Steel Castings. Illustrates and describes a number of tests. 1600 w. Foundry—March, 1909. No. 2944.

The Air-Furnace Process of Preparing White Cast-Iron for the Malleablizing Process. Henry M. Howe and Enrique Touceda. A report of investigations. 2000 w. Bul Am Inst of Min Engrs—March, 1909. No. 3473 F.

Faulty Castings and Their Prevention. Walter J. May. Suggests methods of reducing the number of waste castings. 1400 w. Mech Wld—March 12, 1909. No. 3413 A.

**Cupola Lining.**

Cupola Linings (Das Kupolofenfutter). Discusses the importance of careful selection of materials, the chemical principles involved, etc. 1700 w. Stahl u Eisen—Feb. 24, 1909. No. 3365 D.

The Destruction of Cupola Linings (Wie kleidet man Kupolöfen aus?). Otto Beckmann. Discusses the effect of the lining on the working of the cupola, materials, etc. Ills. 1900 w. Giesserei-Zeitung—Feb. 15, 1909. No. 3373 D.

**Cupola Practice.**

Dry versus Wet Coke for the Foundry Cupola. C. Geiger, in *Stahl und Eisen.* Explains the possibility of obtaining more economical results in the cupola with wet coke than with dry. 1500 w. Ir & Coal Trds Rev—Feb. 19, 1909. No. 2904 A.

**Cutting Metals.**

See Welding, under MACHINE WORKS AND FOUNDRIES.

**Cutting Tools.**

A Practical Machine Tool System for a Railway Shop. W. J. Eddy. Gives the machine tool chart of the Erie Railroad with explanatory notes. 600 w. R R Age Gaz—March 26, 1909. No. 3520.

See also Milling Cutters, under MACHINE WORKS AND FOUNDRIES; Tool Steels, under MATERIALS OF CONSTRUCTION; and Dynamometers, under MEASUREMENT.

**Drills.**

Experiments Upon the Forces Acting on Twist-Drills When Operating on Cast-Iron and Steel. Dempster Smith and R. Poliakoff. A record of experiments made with a double-edged cutting tool in the form of a twist drill. Gives also a brief review of the most important work in this field. Ills. 12600 w. Inst of Mech Engrs—March 18, 1909. No. 3615 N.

**Enamelling.**

Enameled Cast Iron Sanitary Ware. Dillon Underhill. First of a series of articles describing methods of molding, pattern-making, designing, annealing, and enameling. Ills. 3500 w. Foundry—March, 1909. Serial. 1st part. No. 2942.

**Forging.**

Drop Forging. R. E. Bury. Abstract of paper before the Indian Sec. of the Inst. of Mech. Engrs. Considers different methods of die forging, showing the advantages of drop forging. 2500 w. Engr, Lond—March 12, 1909. No. 3428 A.

**Foundry Materials.**

See Pig Iron, under MINING AND METALLURGY, IRON AND STEEL.

**Foundry Practice.**

See Pattern Making, under MACHINE WORKS AND FOUNDRIES.

**Furnaces.**

Electric Annealing Furnaces for Hardening and Tempering High Class Tools. John B. C. Kershaw. Illustrated descriptions of the three types of furnace now in use for small work. 2500 w. Ir Trd Rev—March 4, 1909. No. 2962.

See also Castings, under MACHINE WORKS AND FOUNDRIES.

**Grinding.**

The Manufacture of Steel-Balls for Tumbling Purposes. Illustrates and describes machines and methods of grinding large steel balls. 1200 w. Brass Wld—March, 1909. No. 3442.

**Grinding Machines.**

A New Grinder for Rapid Internal Work. Illustrated detailed description of the Bath double-head internal grinder and its operation. 2000 w. Am Mach—Vol. 32. No. 9. No. 2934.

**Lacquering.**

The Process of Lacquering Brass Bedsteads. Describes a method recently patented by William W. Vincent, by which the tubing is heated by electricity. 1400 w. Brass Wld—March, 1909. No. 3446.

**Lathes.**

Lathe for Turning Large Turbine Rotors. Illustrated description of a large lathe for the Fairfield Shipbuilding & Engineering Co. 600 w. Engng—March 19, 1909. No. 3622 A.

30-In. Crank-Axle Lathe. Illustrated description of a motor-driven lathe, designed for work on locomotive crank-axles. 500 w. Engng—March 12, 1909. No. 3420 A.

Large Work on Cleveland Automatics. Illustrates samples of work and tools used, describing methods. 1200 w. Am Mach—Vol. 32. No. 11. No. 3221.

**Machine Tools.**

Marine Turbine Blading and Shipyard Tools. Illustrates and describes special machines used at the Fore River Shipbuilding Co. and the new form of blading for Curtis marine turbines. 3000 w. Am Mach—Vol. 32. No. 10. No. 3081.

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Modern Swedish Machine Tools. Oskar Kylin. Illustrates and describes representative types. 1500 w. Mach, N Y—March, 1909. No. 2913 C.

See also Bearings, under MACHINE ELEMENTS AND DESIGN.

**Milling Cutters.**

Development of the High Speed Milling Cutter, with Inserted Blades, for High Powered Milling Machines. Wilfred Lewis and William H. Taylor's paper is discussed. 4000 w. Jour Am Soc of Mech Engrs—March, 1909. No. 3464 F.

Clearance of Milling Cutters. Harry A. S. Howarth. Shows graphically the factors that determine the clearance which should be ground. 3000 w. Mach, N Y—March, 1909. No. 2910 C.

**Milling Machines.**

Efficiency Tests of Milling Machines and Milling Cutters. Discussion of A. L. DeLeeuw's paper. 4500 w. Jour Am Soc of Mech Engrs—March, 1909. No. 3465 F.

Milling Machine Tests. P. V. Vernon. Illustrates and describes tests carried out in the workshop of Alfred Hubert, Limited, with a view to collecting data as to the capacity and efficiency. 2000 w. Engr, Lond—March 19, 1909. No. 3623 A.

See also same title, under MACHINE ELEMENTS AND DESIGN.

**Molding.**

Making Molds for Casting Turbine Wheels. Illustrated description of a method invented by Levi J. Wing. 600 w. Brass Wld—March, 1909. No. 3445.

Molding Locomotive Cylinders. Paul R. Ramp. Prize paper. Discusses every phase of foundry practice relating to their production. Ills. 2500 w. Foundry—March, 1909. No. 2945.

**Molding Machines.**

Molding Machine-Made Plowpoints. Illustrates and describes methods of mounting the patterns on a molding machine. 2000 w. Foundry—March, 1909. No. 2947.

Jarring and Hinged Molding Machine. Illustrated description of a large machine for molding car wheel centers. 1500 w. Foundry—March, 1909. No. 2948.

**Molding Sand.**

The Drying of Molding Sand (Ueber das Trocknen des Formsandes). E. Lamberton. Illustrates and describes various drying devices. 1800 w. Stahl u Eisen—Feb. 17, 1909. No. 3362 D.

**Pattern Making.**

The Patternmaker and the Foundry. Remarks on the need of patternmakers having a knowledge of foundry and shop methods, describing different methods of molding a ring separator. Ills. 2000 w. Am Mach—Vol. 32. No. 12. No. 3489.

**Planing Machines.**

A Propeller Planing Machine. Description of a recent design. Ills. 1000 w. Am Mach—Vol. 32. No. 11. No. 3220.

**Presses.**

See same title, under MACHINE ELEMENTS AND DESIGN.

**Punching.**

Some Punching Tests (A propos de quelques Essais de Poinçonnage). Pierre Breuil. Gives results of a series of punching tests on thin sheets of various metals, with discussion. Ills. 4500 w. Rev de Mécan—Feb., 1909. No. 3321 E + F.

See also Steel, under MATERIALS OF CONSTRUCTION.

**Saw Making.**

Making Saws. Ethan Viall. Illustrated description of methods used in making the Atkins saws. 1800 w. Mech, N Y—March, 1909. No. 2911 C.

**Saws.**

What Can Be Done with a Cold Saw. Roger Atkinson. Describes types and the methods of using them. Ills. 1500 w. Ry & Loc Engng—March, 1909. No. 2939 C.

**Shop Appliances.**

Accurate Textile Machinery Making. Illustrates and describes devices used in making the Mayo knitting-machines, outlining the method of manufacture. 1600 w. Am Mach—Vol. 32. No. 12. No. 3486.

Universal Radial Drill Equipped for Jig Work. A. J. Baker. Description of attachments and their use. 900 w. Am Mach—Vol. 32. No. 12. No. 3487.

Flanging, Punching and Welding. Claude Aiken. Illustrates and describes shop equipment and methods. 2000 w. Am Mach—Vol. 32. No. 11. No. 3218.

**Shop Practice.**

Machining Motor Car Twin Cylinders. Considers operations to be performed in machine shop in sequence. Ills. 1200 w. Prac Engr—Feb. 26, 1909. Serial. 1st part. No. 3056 A.

Manufacturing Air-Cooled Cylinders. F. J. Haynes. Some of the processes are illustrated and described. 1000 w. Mach, N Y—March, 1909. No. 2914 C.

Machining the Knee of a Cutter Grinder. A. J. Baker. Illustrates and describes the operations in their order 1200 w. Am Mach—Vol. 32. No. 10. No. 3082.

Method of Making Master Tools for Eyelet Sets. Warren E. Thompson. Illustrates and describes the special machinery. 1600 w. Mach, N Y—March, 1909. No. 2912 C.

**Shops.**

A Modern Tank Works. Illustrations, with description, of works at Shipley, England. 800 w. Engr, Lond—March 19, 1909. No. 3626 A.

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New Wiring-Supplies Building Constructed by the General Electric Company. Illustrated description of a building at Schenectady, N. Y. 1500 w. Elec Rev, N Y—Feb. 27, 1909. No. 2857.

Organization and Equipment of an Automobile Factory. C. B. Owen. Illustrated description of the construction of the Cadillac plant and the design of the product. 5000 w. Mach, N Y—March, 1909. No. 2909 C.

**Tack Making.**

The Methods of Modern Tack Making. Description of machinery that makes from 300 to 2000 tacks per minute. Ills. 1500 w. Am Mach—Vol. 32. No. 9. No. 2935.

**Tempering.**

See Furnaces, under MACHINE WORKS AND FOUNDRIES.

**Welding.**

Water Decomposition by Direct Current and Alternating Current, and Welding with the Oxy-Hydrogen Flame. M. U. Schoop. Suggestions for making oxy-hydrogen gas. 1800 w. Elec-Chem & Met Ind—March, 1909. No. 2984 C.

Welding with the Oxygenite Process. E. F. Lake. Illustrated description of the apparatus and its operation, illustrating samples of work. 2200 w. Am Mach—Vol. 32. No. 11. No. 3222.

Welding and Brazing, with Special Reference to the Welding of Plates (Das Schweissen und Hartlöten mit besonderer Berücksichtigung der Blechschweissung). A review of welding processes, their applications and advantages. Ills. Serial. 1st part. 2200 w. Glasers Ann—Feb. 15, 1909. No. 3396 D.

Welding and Cutting Metals with Oxygen (Autogenes Schweissen und Schneiden mit Sauerstoff). Felix Kagerer. A valuable paper describing the use of the oxygen blowpipe in the shops of the Austrian State Railways. Test results and costs. 7700 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 20, 1909. No. 3550 D.

**Wire Drawing.**

The Carroll Friction Block for Wire Drawing Frames. Illustrated description of the device, with record of performance tests. 2000 w. Ir & Coal Trds Rev—March 12, 1909. No. 3431 A.

## MATERIALS OF CONSTRUCTION.

**Alloys.**

The Art of Making Alloys. Percy Longmuir. From a paper before the British Foundry Assn., giving practical suggestions. 1200 w. Sci Am Sup—March 13, 1909. No. 3579.

Alloys for Use in the Brass Foundry. Joseph H. Hart. Discusses the results obtained by alloying various metals. 2500 w. Foundry—March, 1909. No. 2943.

Monel Metal. David H. Browne. A brief description of its properties and uses. 1000 w. Elec-Chem & Met Ind—March, 1909. No. 2985 C.

**Alloy Steels.**

See Rails, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

**Bakelite.**

Bakelite. Abstract of a paper by Dr. L. H. Bakeland, before the Am. Chem. Soc. giving information concerning the manufacture and properties of this new substance. 2500 w. Elec-Chem & Met Ind—March, 1909. No. 2983 C.

**Brass.**

Cold Working and Tension Tests (Kaltbearbeitung und Zugversuch). R. Stribeck. Gives results of extended tests on brasses. Ills. 7000 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1909. No. 3561 D.

**Lead.**

Lead (Bijdrage tot de Kennis van het Lood). H. Baucke. A metallographic study of lead. Ills. 5200 w. De Ingenieur—Feb. 20, 1909. No. 3574 D.

**Metallography.**

The Application of the Microscope to the Study of Metals. Walter Rosenhain. An outline of the methods of studying metals and alloys with the microscope. Ills. Discussion. 6500 w. Jour Soc of Arts—March 12, 1909. No. 3400 A.

See also Lead, and Steel, under MATERIALS OF CONSTRUCTION.

**Steel.**

The Shearing Resistance of Mild Steel in Punching. Y. Sekiguchi. A report of tests. 500 w. Am Mach—Vol. 32. No. 10. No. 3083.

The Hardness of Steels at Low Temperatures (La Dureté des Aciers aux basses Températures) M. F. Robin. Gives the results of an experimental investigation of various steels. Ills. 4000 w. Rev de Métal—Feb., 1909. No. 3306 E + F.

An Additional Note on the Hardness of Heated Steel (Note additionelle au Mémoire sur la Dureté à Chaud des Aciers). M. F. Robin. Ills. 500 w. Rev de Métal—Feb., 1909. No. 3307 E + F.

**Tool Steels.**

High-Speed Tool Steels. An account of actual tests carried out at several Sheffield works. 2500 w. Engr, Lond—March 19, 1909. No. 3625 A.

## MEASUREMENT.

**Dynamometers.**

Nicolson's Universal Machine-Tool Dynamometer. Illustrated description of apparatus for determining the pressures on the point of the tool. 1500 w. Engng—Feb. 19, 1909. No. 2893 A.

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**Hardness.**

Principles of the Scleroscope for Measuring Hardness. Thomas J. Fay. Illustrated description of the Shore scleroscope, explaining its uses. 3500 w. Automobile—March 4, 1909. No. 2966.

**Impact Test.**

Comparative Static and Dynamic Tests on Notched Bars (Vergleichende statische und dynamische Kerbbiegeproben). A. Leon and P. Ludwik. Results of tests at the Technical High School, Vienna. Ills. 2300 w. Oest Wochenschr f d Oeffent Baudienst—Feb. 13, 1909. No. 3399 D.

**Pyrometry.**

A Practical Note on Thermo-electric Pyrometers. Charles H. Wilson. An article calling attention to a mistake often made by users of thermo-electric pyrometers. 1500 w. Elec-Chem & Met Ind—March, 1909. No. 2987 C.

**Testing Machines.**

A Ball-Bearing Testing Machine and Its Work. Illustrated description of an effective machine and its working. 2500 w. Am Mach—Vol. 32. No. 9. No. 2937.

**Torsionmeters.**

Measurement of Marine Engine Power by Torsionmeters. Joseph Menmuir. Abstract of a paper read at meeting of the Greenock Assn. of Engrs. & Shipbldrs. Describes types and their uses. 3000 w. Engr, Lond—Feb. 19, 1909. No. 2901 A.

## POWER AND TRANSMISSION.

**Air Compressors.**

See Electric Pumping, under HYDRAULIC MACHINERY.

**Belt Driving.**

The Transmission of Power by Leather Belting. Discussion of Carl G. Barth's paper. 16000 w. Jour Am Soc of Mech Engrs—March, 1909. No. 3467 F.

**Electric Driving.**

The Industrial Application of the Electric Motor, as Illustrated in the Gary Plant of the Indiana Steel Company. B. R. Shover. Illustrated detailed description of the plant and the applications of electric power. 9000 w. Pro Am Inst of Elec Engrs—March, 1909. No. 3477 F.

Electric Main Drives in German Mills. Eugene Eichel. Discusses the development of electric driving in Germany. The first part illustrates and describes the generators used. 5500 w. Ir Trd Rev—March 4, 1909. Serial. 1st part. No. 2961.

**Electric Power.**

Electricity and Its Application to the Reduction of Waste. Arnold B. Gridley. Abstract of paper read before the Cleveland Inst. of Engrs. Considers its application to the reduction of waste of capital expenditure, labor, coal, oil, water, space, etc. 3500 w. Engng—March 5, 1909. No. 3174 A.

**Gas Power.**

The Gas Power Plant as a Means of Fuel Conservation. Dr. Charles E. Lucke. A review of the fundamental principles on which its substitution for steam depends. 2000 w. Engineering Magazine—April, 1909. No. 3529 B.

See also Blast-Furnace Gas, under MINING AND METALLURGY, COPPER.

**Gas vs. Steam.**

Graphical Comparison of Steam and Gas Engines as Power Producers. Harold Whiting Slauson. A comparison of the relative efficiencies, fuel consumption and cost. 900 w. Ir Age—March 11, 1909. No. 3076.

**Power Plants.**

The Design of Steam-Electric Power Plants. Frank Koester. Discusses the location, general arrangement, building, and boilers in the present number. Ills. 2500 w. Elec Rev, N Y—March 13, 1909. Serial. 1st part. No. 3130.

Reducing the Cost of Power in Works and Factories. Joseph A. Jeckell. Read before the Birmingham and District Elec. Club, England. Brief consideration of power waste, and the possible economies. 2500 w. Ir & Coal Trd Rev—March 19, 1909. No. 3631 A.

Power Equipment of the New Hecker Flour Mills, New York City. Briefly describes this recently completed mill on the East River, the largest on the Atlantic Coast. Describes the solution of interesting driving problems. Ills. 3500 w. Eng Rec—March 27, 1909. No. 3542.

**Power-Plant Testing.**

Trials of a Steam-Turbine Plant. A report of trials of a steam plant at Greenvale Mill, near Manchester, Eng. The mill is electrically driven and the motors are supplied with current from a 500-kw. Brush-Parsons turbo-alternator. Ills. 5000 w. Engng—Feb. 26, 1909. No. 3071 A.

Continuous Testing of Steam Plants. James E. Lea. Abstract of paper before the Manchester Assn. of Engrs. On the value of such testing and its relation to efficiency and economy. 4500 w. Mech Engr—March 19, 1909. No. 3609 A.

**Rope Driving.**

The Transmission of Power by Ropes. Edwin Kenyon. Abstract of paper read before the S. Wales Inst. of Engrs. An examination of the practical details upon which the success of rope-driving depends, giving a table of h.p. for different sizes. Ills. 6000 w. Engng—March 12, 1909. Serial. 1st part. No. 3422 A.

Rope-Driving at Rolling Mills and Collieries. Descriptions and illustrations from paper before the S. Wales Inst. of Engrs. 1500 w. Ir & Coal Trds Rev—March 5, 1909. No. 3180 A.

*We supply copies of these articles. See page 319.*

**Shafting.**

Methods of Attaching Shafting in Reinforced Concrete Buildings. William M. Bailey. Read before the Nat. Assn. of Cement Users. Illustrated description of different systems used. 1500 w. Eng Rec—March 13, 1909. No. 3108.

**Tidal Power.**

Tidal Power. W. C. Horsnaill. The present article describes some early tide wheel arrangements, and gives a study of the principles involved. Ills. 2000 w. Engr, Lond—Feb. 26, 1909. Serial. 1st part. No. 3073 A.

**Wind Power.**

Wind Power. E. Lancaster Burne. Considers the wind in its relation to windmills, the motor, and its applications. Ills. 3000 w. Engr, Lond—March 19, 1909. Serial. 1st. part. No. 3624 A.

**Boiler Corrosion.**

The Corrosive Action of Magnesian and Other Waters on Steam Boilers. Dr. J. Grossmann. Reviews the investigations made by H. Ost, published in 1902, and states the results. Also gives method of determining in a general way, the effect of different waters. 2200 w. Engr, Lond—March 12, 1909. No. 3424 A.

**Boiler Design.**

Stresses on Cylindrical Shells. H. S Jeffrey. A mathematical study. 1200 w. Boiler Maker—March, 1909. No. 3078.

The Riveted Joints of Cylindrical Boilers. H. K. Spencer. Discusses only the joints commonly used in cylindrical boilers. Ills. 4000 w. Boiler Maker—March, 1909. No. 3080.

**Boiler Explosions.**

Boiler Explosions During 1908. Annual summary of explosions in the United States, Canada and Mexico. 400 w. Locomotive—Jan., 1909. No. 3189.

Ten Thousand Boiler Explosions. Reviews the number of explosions in the United States and adjacent parts of Canada and Mexico during the period from Oct. 1, 1867, to Jan. 1, 1909. 1800 w. Locomotive—Jan., 1909. No. 3188.

**Boiler Failures.**

Some Recent Board of Trade Reports on Boiler Failures. Brief illustrated reports of 16 cases. 2500 w. Mech Engr—Feb. 19, 1909. No. 2885 A.

**Boiler Furnaces.**

Bridgewalls in Theory and Practice. W. H. Wakeman. Describes defects in bridgewalls, some too low, some too high, etc. 1000 w. Power—March 9, 1909. No. 3039.

**Boiler Management.**

Scientific Boiler Control. G. A. H. Binz. Before the Inst. of Marine Engrs. Discusses good and bad stoking, advocating the use of $CO_2$ recorders for the automatic analysis of the products of combustion, and giving an illustrated description of the "Sarco" recorder, type B. 4500 w. Can Engr—Feb. 26, 1909. No. 2868.

**Boilers.**

The "Yorkshire" Boiler. W. H. Casmey. Abstract of a lecture before the Halifax Engrs. & Firemen's Assn. Explains its advantages over any other boiler of the cylindrical type. Ills. 2500 w. Mech Engr—March 12, 1909. No. 3411 A.

**Boiler Scale.**

Impurities Causing Scale and Corrosion. J. C. William Greth. Abstract of a paper read before the Am. Inst. of Chem. Engrs. Deals with the general characteristics of salts, gases, and acids which cause scale and corrosion in boilers. 4400 w. Power—March 2, 1909. No. 2908.

Incrustation and Corrosion. R. E. M'Namara. Discusses causes and prevention in steam boilers and pressure vessels. Ills. 3000 w. Boiler Maker—March, 1909. Serial. 1st part. No. 3079.

**Boiler Tests.**

Heat Transmission in Water-Tube Boilers Fired with Inferior Lignite (Der Wärmeübergang am Wasserrohrkessel mit Befeuerung durch minderwertige Braunkohle). Paul Fuchs. Gives results of elaborate boiler trials of lignite fuel. Ills. 5800 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1909. No. 3564 D.

**Boiler Waters.**

Proper Treatment of Boiler Feed Water. A. J. Boardman. Gives data of a plant which reduced maintenance charges $160 per month by analyzing and treating feed water. 2000 w. Power—March 23, 1909. No. 3438.

The Quality of Surface Waters in the North Central States. R. B. Dole. Presents results of investigations carried out by the U. S. Geol. Survey. Discussion. 9000 w. Pro W Ry Club—Feb. 16, 1906. No. 3193 C.

See also Boiler Corrosion, under STEAM ENGINEERING.

**Condensers.**

Researches on Surface Condensers for Steam Turbines (Versuche über Oberflächenkondensationen, insbesondere für Dampfturbinen). E. Josse. An exhaustive investigation of the whole condensation problem. Ills. Serial. 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Feb. 27, 1909. No. 3571 D.

**Engine Balancing.**

Steam Engine Counterbalancing. F. H Ball. Describes the problem of balancing and describes an engine in which practically perfect balance has been achieved by simple means. 2000 w. Ir Age—March 18, 1909. No. 3215.

*We supply copies of these articles. See page 319.*

**Engine Efficiency.**

The Efficiency of Heat Engines. R. W. Angus. Read before Toronto Univ. Engng. Soc. Considers the limitations of such engines and their possibilities. 3000 w. Mech Wld—March 12, 1909. No. 3414 A.

**Engine Pressures.**

Expensive versus Inexpensive Back Pressure. W. H. Wakeman. Describes interesting examples, pointing out defects. Ills. 4500 w. Power—March 30, 1909. No. 3586.

**Engines.**

Engineering in the Eighteenth Century. Edward P. Buffet. Illustrates and describes quaint engines used, and features of steam engineering practice. 4000 w. Power—March 30, 1909. No. 3587.

See also Gas vs. Steam, under POWER AND TRANSMISSION.

**Entropy Diagram.**

Diagram of the Properties of Saturated and Superheated Steam at Various Temperatures and Pressures (Diagramme des Propriétés de la Vapeur saturée et surchauffée aux différentes Pressions et Températures). J. Izart. Describes an entropy diagram taking account of the variation of the specific heat with temperature and pressure. Ills. 4000 w. Rev de Mécan—Feb., 1909. No. 3322 E + F.

**Fuel Oil.**

Fuel Economy Tests. Discussion of two papers by C. R. Weymouth on tests of fuel oil. 3500 w. Jour Am Soc of Mech Engrs—March, 1909. No. 3466 F.

**Fuels.**

Peat and the Production of Power. Herbert Philipp. Considers ways of using peat for power and heating purposes. 2500 w. Elec-Chem & Met Ind—March, 1909. No. 2988 C.

The Purchase of Municipal Coal Supplies in New York City. Information from a report by Messrs Walter N. Polakov and William A. Russell to the Board of Apportionment of New York, on preventable wastes and losses in the plants of the municipal government of the city. 3000 w. Eng Rec—March 20, 1909. No. 3269.

See also Boiler Tests, under STEAM ENGINEERING.

**Fuel Testing.**

Comparative Tests of Coal. Peter H. Bullock. Describes a simple testing apparatus and tests made. 1800 w. Power —March 16, 1909. No. 3185.

Government Tests of Coal as Fuel for House Heating Boilers. Reviews the U. S. Geol. Survey tests on sectional steam boilers, at St. Louis, and on sectional cast-iron and round boilers at Urbana. Ill. 5000 w. Heat & Vent Mag—March, 1909. No. 3452.

Heating-Value Tests on Coal, Coke and Anthracite (Heizwertversuche an Kohlen, Koks und Anthrazit). Hans Winkelmann. Describes the method of making calorimeter tests and gives results. Serial. 1st part. 1700 w. Giesserei-Zeitung—Feb. 15, 1909. No. 3372 D.

**Heat Transmission.**

The Transmission of Heat Through Boiler Plates. The first of a series of articles aiming to concentrate all the useful information concerning the transmission of heat to water under the ordinary conditions of steam generation. 4500 w. Engr, Lond—Feb. 19, 1909. Serial. 1st part. No. 2900 A.

**Indicator Diagrams.**

Indicator Diagrams. W. A. Tookey. Read before the Assn. of Engrs.-in-Charge. Gives some cards and discusses the causes of distortion and the remedies. 1800 w. Mech Wld—March 19, 1909. Serial. 1st part. No. 3610 A.

Inaccuracies of Indicator Diagrams. Julian C. Smallwood. Discusses the distortion of pencil motion, inaccuracies in mechanism and spring and methods of calibration. Ills. 2500 w. Power—March 16, 1909. No. 3184.

**Mechanical Stokers.**

A New Bennis High-Temperature Coking-Stoker. Illustrated description of coking-stoker claiming high efficiency. 1500 w. Engng—Feb. 19, 1909. No. 2894 A.

**Piston Rings.**

Piston Packing Rings. James Andrews Read before the W. of Scotland Assn. of Foremen Engrs. Shows that the same packing rings do not behave alike in all cases, and gives a study of their action under various conditions. Ills. 6500 w. Mech Engr—March 12, 1909. No. 3412 A.

**Safety Valves.**

Some Recent Developments in Marine Safety-Valves. J. Hamilton Gibson. Reports tests which indicate a striking advance in safety-valve design. Ills. 800 w. Engng—Feb. 26, 1909. No. 3070 A.

Safety Valve Capacity. Philip G. Darling. Illustrates and describes a method employed to determine safety valve lifts, giving results of tests. 4500 w. R R Age Gaz—March 5, 1909. No. 3032.

**Smoke Prevention.**

The Reduction of Smoke in Factory Districts (Zur Frage der Rauchverminderung im Industriebezirke). Dr. Klocke. Discusses the smoke nuisance in cities and describes methods and apparatus designed to lessen it. Ills. 2800 w. Stahl u Eisen —Feb. 3, 1909. No. 3358 D.

**Steam Pipes.**

Flanged Pipe Joints for High Pressure. William F. Fischer. Illustrates and de-

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scribes types of screwed joint, shrunk, peened and riveted; variations in lap joints, and the welded flanges. 2500 w. Power—March 2, 1909. No. 2907.

Prevention of Water Hammer in Steam Pipes. Charles L. Hubbard. Discusses causes and cures. Ills. 2000 w. Met Work—March 6, 1909. No. 2981.

Drawing High-Pressure Steam Lines. William F. Fischer. Discusses the effect of water collecting in the steam piping, and methods of drawing it. Ills. 3000 w. Power—March 9, 1909. No. 3040.

Pipe-Hangers. W. H. Wakeman. Illustrates and describes a variety of convenient devices. 1800 w. Elec Wld—March 4, 1909. No. 2993.

**Steam Properties.**

Energy Charts for Steam. R. M. Neilson. Gives charts prepared by the writer with explanation of their use. Plate. 1500 w. Power—March 16, 1909. No. 3187.

A New Determination of the Saturation Pressure of Steam Between 50 and 200 Degrees (Eine neue Bestimmung des Sättigungsdruckes von Wasserdampf zwischen 50 und 200°). L. Holborn and F. Henning. Report from the Physikalisch-Technischen Reichsanstalt. 2200 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1909. No. 3569 D.

See also Entropy Diagram, under STEAM ENGINEERING.

**Stoking.**

Firemen (Du Chauffeur). Ant. Michot. Discusses the training of firemen, the principles of economical stoking, the Liège firemen's competition, etc. Serial. 1st part. 4000 w. All Indus—Feb., 1909. No. 3328 D.

**Superheating.**

Superheat and Its Advantages. Vernon Smith. Considers the advantages and difficulties of superheating. 2500 w. Prac Engr—March 19, 1909. No. 3605 A.

**Turbine Efficiency.**

Steam-Turbine Efficiency. Editorial on the inaccuracy of the statement that the efficiency is less when the number of stages is increased. 2500 w. Engng—Feb. 19, 1909. No. 2895 A.

**Turbine Nozzles.**

The Temperature Gradient in De Laval Steam-Nozzles (Abridged). Cyril Batho. Describes researches made to determine the temperature gradient along a steam-turbine nozzle. 4000 w. Inst of Civ Engrs—No. 3713. No. 3205 N.

**Turbine Plants.**

Typical Low-Pressure Steam Turbine Plant. J. R. Bibbins. A double-flow turbine utilizing the exhaust of two 750-kw. Corliss engines is described. Ills. 2000 w. Power—March 16, 1909. No. 3183.

Plant in Public Service Building, Milwaukee. Osborne Monnett. Illustrated description of a large non-condensing turbine plant, operating against 22 pounds absolute back pressure, to furnish exhaust steam for district heating. 2500 w. Power—March 9, 1909. No. 3037.

**Turbines.**

The Increased Expansion of Steam Attainable in Steam Turbines. Hon. C. A. Parsons. The James Watt lecture at Greenock. The fundamental principles of steam, discovered by Watt and their applications, especially in steam turbines. 5000 w. Nature—Feb. 25, 1909. No. 3043 A.

The Field and Future of the Low-Pressure Steam Turbine. Ira N. Hollis. This first article of a series discusses the fundamental theory and fields of usefulness. 4000 w. Engineering Magazine—April, 1909. No. 3524 B.

The Steam Turbine for Use with Mixed Loads (Die Dampfturbine in Betrieben mit gemischtem Energiebedarf). A. Dahme. Illustrates and discusses the use of low-pressure turbines in plants where steam is used for a variety of purposes. 2200 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 10, 1909. No. 3378 D.

Steam Turbines, with Special Reference to the Zoelly Turbine (Stoomturbines met speciale Vermelding der Zoelly-Stoomturbine). J. Strumphler. Discusses their design and operation. Ills. 6000 w. De Ingenieur—Feb. 13, 1909. No. 3573 D.

The Kolb Electra Steam Turbine (Turbines à Vapeur electra, Système Kolb). A. Mauduit. Illustrated detailed description. Serial. 1st part. 2400 w. Génie Civil—Feb. 13, 1909. No. 3343 D.

See also Condensers, under STEAM ENGINEERING; and Steam Turbines, under MARINE AND NAVAL ENGINEERING.

**Turbine Tests.**

Tests of a 150-Kilowatt Steam Turbine (Versuche an einer Rateau-Dampfturbine von 150 KW.). Anton Gramberg. Describes the tests and gives the results in curves. Ills. 3500 w. Zeitschr d Ver Deutscher Ing—Feb. 13, 1909. No. 3562 D.

Tests of a 300-Kilowatt Parsons Turbine (Untersuchung einer 300 KW- Parsonsturbine). W. Gensecke. A comprehensive discussion of a very thorough test. Ills. Serial. 1st part. 3000 w. Zeitschr f d Gesamte Turbinenwesen—Feb. 27, 1909. No. 3381 D.

See also Power-Plant Testing, under POWER AND TRANSMISSION.

**Valve Gears.**

Marine Engine Valves and Valve Passages. Albert H. Ziegler. Discusses their design in detail. Ills. 5500 w. Rudder—March, 1909. No. 3128 D.

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## TRANSPORTING AND CONVEYING.

**Bucket Elevators.**

Mechanical Elevator. T. A. Rickard. Illustrates and describes a machine devised for conditions in Alaska, in handling the gravel deposits by either the hydraulic or dredging methods. 1600 w. Min & Sci Pr—March 20, 1909. No. 3505.

**Cableways.**

The Wetterhorn Cableway at Grindelwald, Switzerland (Le Funiculaire du Wetterhorn à Grindelwald, Suisse). Illustrated description of a long span ropeway up the side of the Wetterhorn. Plate. Génie Civil—Feb. 13, 1909. No. 3340 D.

**Coal Handling.**

Electric Suspension Railways for Handling Coal and Coke. F. A. Talbot. Illustrates and describes plants recently erected in Germany. 1700 w. Elec Wld—Feb. 25, 1909. No. 2869.

New Coal and Ore Loading Plant at Schweigern. Illustrates and describes an extensive plant. 1500 w. Ir & Coal Trds Rev—March 5, 1909. No. 3178 A.

**Conveyors.**

The Belt Conveyor in Railway Building. C. Kemble Baldwin. Describes adaptation of belt conveyors to this class of service. 2500 w. R R Age Gaz—March 26, 1909. No. 3519.

A Notable Conveyor Installation. Illustrated description of the link-belt equipment in the Champion Fiber Company's works. 1800 w. Ir Age—March 4, 1909. No. 2931.

See also Ore Handling, under TRANSPORTING AND CONVEYING.

**Cranes.**

Traveling Cranes for Building Concrete Lock Walls at Brownsville. Outlines the work in progress, especially describing the huge gantry cranes, running on a trackway supported on pile trestles, which has proved its efficiency. Ills. 2500 w. Eng Rec—Feb. 27, 1909. No. 2845.

**Crane Trolleys.**

Electrically Operated Crane Trolleys (Motorlaufwinden). C. Michenfelder. Illustrates and describes several types of electric-crane trolleys and hoists. Serial, 1st part. 1200 w. Elektrotech Rundschau—Feb. 10, 1909. No. 3555 D.

**Derricks.**

Steel Derricks for Erecting Tall Buildings. Illustrated description of derricks used in New York City. 1200 w. Eng Rec—March 27, 1909. No. 3538.

**Ore Handling.**

Shipping Iron Ore at Aquilas, Spain. (Abridged.) Gustave Gillman. Illustrates and describes the arrangements for loading and storing. 2500 w. Inst of Civ Engrs—No. 3716. No. 3204 N.

Handling Ore at Copper Queen Mines, Bisbee. Walter Gardner. Includes electric haulage underground, and the transfer to railroad cars by means of belt conveyors. Ills. 1200 w. Eng & Min Jour—March 13, 1909. No. 3117.

See also Coal Handling, under TRANSPORTING AND CONVEYING; and Docks, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

**Transporters.**

The Barry Transporter. Illustrated description of the present form of this transporter, calling attention to improvements introduced. 2500 w. Engng—March 5, 1909. No. 3166 A.

## MISCELLANY.

**Aeronautics.**

Lectures on Aviation (Conférences sur l'Aviation). M. Renard. The first discusses aerodynamics, the resistance of the air and its influence on aviation problems, etc. Serial, 1st part. 6300 w. Bul Soc d'Encour—Jan., 1909. No. 3310 G.

Modern Aeronautics (Ueber moderne Flugtechnik). Artur Boltzmann. An illustrated review of aeronautic theory and achievements. Serial, 1st part. 2000 w. Zeitschr d Oest Ing u Arch Ver—Feb. 5, 1909. No. 3397 D.

The Flight of Birds. F. W. Lanchester. An illustrated study. 3500 w. Engr, Lond—Feb. 19, 1909. Serial, 1st part. No. 2903 A.

The Rôle of Viscosity in Air Support of a Moving Aëroplane. Frank W. Very. Gives theories and experiments of various investigators, especially considering Prof. Langley's views which the writer believes to be wrong. 7000 w. Tech Qr—Dec., 1908. No. 3441 E.

The Stability of Aeroplanes (Stabilité des Aéroplanes.—Surface métacentrique). M. Brillouin. An elaborate mathematical discussion of the conditions of stability and the design of aeroplanes. Ills. Serial, 1st part. 6500 w. Rev de Mécan—Feb., 1909. No. 3319 E + F.

The Design of Aeroplanes (Die Berechnung von Gleitfliegern). A. Baumann. A mathematical discussion. Ills. Serial, 1st part. 5500 w. Zeitschr d Ver Deutscher Ing—Feb. 20, 1909. No. 3566 D.

A Note on the Theory and Construction of Aeroplanes and Their Propellers (Beitrag zur Theorie und Konstruktion der Drachenflieger und Luftschrauben). G. Killat. Mathematical discussion of propeller design. Ills. 3700 w. Der Motorwagen—Feb. 20, 1909. No. 3393 D.

Tests of Stationary Aerial Propellers (Essais d'Hélices au Point fixe). M. Boyer-Guillon. Gives results obtained in the Conservatoire National des Arts et Métiers. Ills. 4000 w. Rev de Mécan—Feb., 1909. No. 3320 E + F.

*We supply copies of these articles. See page 319.*

Progress in the Construction of Flying Machines (Fortschritte in der Konstruktion dynamischer Flugapparate). Ansbert Vorreiter. A review of the more recent aeroplanes. Ills. 2200 w. Zeitschr d Mit Motorwagen-Ver—Feb. 28, 1909. No. 3392 D.

The British Army Aeroplane. An illustrated article giving some impressions and comparisons. 2000 w. Auto Jour—Feb. 27, 1909. No. 3048 A.

Test of the Bell Tetrahedral Cell Aeroplane in Nova Scotia. Illustrated account. 500 w. Sci Am—March 13, 1909. No. 3133.

The Human Side of Flying. H. Massac Buist. An attempt to introduce the reader to Messrs. Orville and Wilbur Wright at Pau. Ills. 1500 w. Auto Jour—March 6, 1909. Serial, 1st part. No. 3145 A.

On Dirigible Balloons. Discusses progress shown in recent types, some of the risks, and a few disasters. 3500 w. Engng—March 5, 1909. No. 3165 A.

**Efficiency.**

Efficiency. Alfred T. Best. An explanation of the technical meaning of efficiency, giving particulars of the ratios usually obtained in various types of machinery, and examples of calculations. 2000 w. Mech Engr—March 19, 1909. No. 3608 A.

**Review of 1908.**

Mechanical Engineering in 1908 (La Mécanique en 1908)). M. G. Richard A general review of progress, particularly in steam engineering. Ills. 6000 w. Bul Soc d'Encour—Jan., 1909. No. 3309 G.

**Sugar Machinery.**

The Hyros-Rak Diffusion Plant. Illustrated description of an apparatus designed for extracting sugar from beet by a continuous process of diffusion. 900 w. Engng—Feb. 26, 1909. No. 3064 A.

A Large Sugar-Cane Mill. Illustrated description of a new eleven-roller sugar-cane mill, said to be the largest and most powerful yet constructed. 1000 w. Engr, Lond—Feb. 19, 1909. No. 2902 A.

# MINING AND METALLURGY

## COAL AND COKE.

**Bengal.**

The Coal Mining Industry in Bengal. Glen George. Information concerning the coals, methods of working, labor and costs. Ills. 2500 w. Eng & Min Jour—March 13, 1909. No. 3120.

**Briquetting.**

Coal Briquetting at the Hartshorne Plant. Charles T. Malcomson. Illustrated description of plant and process of making briquettes from slack. 3000 w. Mines & Min—March, 1909. No. 2957 C

**Coal Cutting.**

Coal Cutting by Machinery in England. J. Hinton. Brief notes expressing opinions of mining experts. 800 w. Eng & Min Jour—March 27, 1909. No. 3533

Electric Coal Cutting at the Julius V Colliery, Brüx (Ueber den elektromaschinellen Schrämbetrieb am k. k. Schachte Julius V bei Brüx). Oskar Mayer and Jaroslav Plzak. Describes the Siemens-Schuckert machines used, the practice, and the results. Ills. 2600 w. Oest Zeitschr f Berg u Hüttenwesen—Feb. 27, 1909. No. 3368 D.

**Coke Ovens.**

An Elongated Coke Oven. W. R. Elliott. Illustrated description of a method of coking by which coal is charged into ovens on trains of cars and hauled out when coked. 2500 w. Mines & Min—March, 1909. No. 2953 C.

Progress in By-Product Coke-Oven Construction at Indianapolis. Illustrated detailed description of plant to supply both gas and fuel. 2500 w. Pro Age—March 15, 1909. No. 3116.

**Coke-Squeezing Machines.**

Electrically Operated Coke-Squeezing Machines. Alfred Gradenwitz. Illustrated descriptions of machines at European mines. 800 w. Eng & Min Jour—March 27, 1909. No. 3532.

**Coking.**

Washed Coal for Coke Making. Walter J. May. Brief consideration of the possibility of making good coke from coal wastes. 1200 w. Prac Engr—March 12, 1909. No. 3409 A.

See also Washing, under COAL AND COKE.

**Coking Plants.**

Coking Plant at the Midland Coal, Coke and Iron Company, Limited, Apedale, Staffs. Illustrated description. 1500 w. Ir & Coal Trds Rev—March 19, 1909. No. 3630 A.

Gas and Electric Plants at Collieries. Mr. Holt. Paper read before the Nat. Assn. of Col. Mgrs. Deals principally with the plants at the Powell Duffryn Colliery. 3500 w. Ir & Coal Trds Rev—March 5, 1909. No. 3181 A.

**Electric Power.**

The Application of Electricity to Mining. W. E. Dickinson. Specially consid-

ers the application of electricity to coal mining, and the advantage of an a. c. system. 2500 w. Sibley Jour of Engng—Feb., 1909. No. 3251 C.

Electric Installations of the Laura and Vereeniging Collieries (Installations électriques des Charbonnages réunis Laura et Vereeniging). Albert Genart. Illustrated description of the plants of this company in Holland. 6800 w. All Indus—Feb., 1909. No. 3325 D.

See also Coking Plants, under COAL AND COKE.

**Explosions.**

Ignition of Firedamp Mixtures by Incandescent Electric Filaments and Sparks. H. Couriot and J. Meunier, in *Bul. Soc. Indus. Min.* Report of tests. 900 w. Col Guard—Feb. 26, 1909. No. 3061 A.

Lick Branch Disaster. H. H. Stock. Maps and description of the mine, with reports of the mining inspectors and other investigators. 7000 w. Mines & Min—March, 1909. No. 2954 C.

**Illinois.**

Coal Deposits and Oil Field Near Duquoin, Ill. Jon Udden. Describes the geology, the deposits and production. 2000 w. Min Wld—March 13, 1909. No. 3126.

**Mining.**

Maximum Recovery of Coal. H. V. Hesse. Shows the waste of early methods of mining in the Georges Creek region, suggesting more economic methods. Ills. 4400 w. Mines & Min—March, 1909. No. 2957 C.

I. Notes on Working Thick Coal. II. Brickwork Dams in Thick Coal. Two short papers by Lawrence Holland, with short discussion. 4000 w. Col Guard—Feb. 19, 1909. No. 2891 A.

The Best Methods of Working Seams of Coal in Steep Measures. H. A. Staples. From a prize paper, Lewis Prize Competition, 1908. Ills. 2500 w. Col Guard—March 19, 1909. Serial, 1st part. No. 3613 A.

Progress and Improvements in Mining in Austria (Fortschritte und Verbesserungen beim Bergbaubetrieb in Oesterreich). The first part of the serial discusses improvements in hoisting methods and appliances. Ills. Serial, 1st part. 1200 w. Oest Zeit f Berg u Hüttenwesen—Feb. 6, 1909. No. 3366 D.

See also Coal Cutting, under COAL AND COKE; and Haulage, under MINING.

**Montana.**

The Great Falls Coalfield in Montana. A. T. Shurick. Describes the deposit, reviewing past and present operations, methods, etc. Ills. 2500 w. Eng & Min Jour—March 20, 1909. No. 3261.

**New Zealand.**

See same title, under GOLD AND SILVER.

**Peat.**

The Peat Resources of the United States. Charles A. Davis. A summary of their extent and uses. 4500 w. Engineering Magazine—April, 1909. No. 3528 B.

See also Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

**Production.**

The World's Coal Production and Consumption. Information from the annual statement of the Board of Trade. 3000 w. Col Guard—Feb. 26, 1909. No. 3062 A.

**Rescue Appliances.**

Recent Advances in Means of Saving Life in Coal Mines. Abstract of a lecture by Sir Henry Cunyngham. Describes some of the dangers in mining, and improvements in safety lamps, explosives, and rescue apparatus. 4000 w. Col Guard—Feb. 26, 1909. No. 3060 A.

**Screening.**

The "Perfex" Stone Screening Machine. Illustrates and describes this improved machine and its operation. 1000 w. Col Guard—March 5, 1909. No. 3162 A.

**Washing.**

Washing and Coking Tests of Coal at the Fuel-Testing Plant, Denver, Colo., July 1, 1907, to June 30, 1908. A. W. Belden, G. R. Delamater, and J. W. Groves. Describes investigations undertaken by the U. S. Government for the purpose of increasing efficiency in the utilization of the fuel supply. Ills. 9500 w. U S Geol Surv—Bul. 368. No. 3197 N.

## COPPER.

**Arizona.**

The Copper Creek Mining District, Arizona. R. Roy Sibley. Map, plans, and information in regard to this new and promising copper mining district. 1500 w. Min Wld—March 13, 1909. No. 3125.

**Australia.**

Recent Mineral Discoveries, Northern Territory. H. Y. L. Brown. An account of discoveries of copper ores, carrying gold, silver and some lead, arsenic, etc. 4000 w. Aust Min Stand—Jan. 20, 27, 1909. Serial, 2 parts. No. 3044 each B.

The Mining Industry in Queensland. Gerard W. Williams. Describes the copper-lead-silver mines near Chillagoe and the smelting methods. 4000 w. Eng & Min Jour—March 20, 1909. No. 3265.

Queensland's Great Copper Field. John Plummer. Information concerning the Cloncurry field. 1200 w. Min Wld—March 6, 1909. No. 3020.

The Mount Morgan Gold and Copper Mine. Gerard W. Williams. Illustrated description of the deposits, methods of mining and milling. 2500 w. Eng & Min Jour—March 27, 1909. No. 3531.

*We supply copies of these articles. See page 319.*

**Blast-Furnace Gas.**

Power from Copper Blast-Furnace Gases. Robert Schorr. Information concerning the furnaces at Mansfeld, Germany, and their operation. They yield gas for power equivalent to 7.4 h.p. per ton of ore treated. 2000 w. Eng & Min Jour—Feb. 27, 1909. No. 2864.

**British Columbia.**

Mining on the Queen Charlotte Islands, B. C. J. F. Bledsoe. An illustrated article giving information in regard to copper deposits of value. 2000 w. Min Wld —March 20, 1909. No. 3436.

Mining Methods and Equipment at the British Columbia Copper Company's Mother Lode Mine. M. D. McIntosh. Read before the Can. Min. Inst. A brief description of the system. 1000 w. Can Min Jour—March 15, 1909. No. 3260.

**California.**

The Balaklala Consolidated Copper Company. Abstract of an official report giving a statement of the general conditions and summaries of mine and smelter operations for 1908. Ills. 1500 w. Eng & Min Jour—March 6, 1909. No. 2980.

**Extraction.**

A New Process for Reducing Copper. O. Froelich. Condensed translation from *Elektrochemische Zeit.* Gives a new method for all grades of ores, which can be applied at the mine. 2000 w. Sci Am Sup—March 27, 1909. No. 3583.

**Lake Superior.**

The Localization of Values in Ore Bodies and the Occurrence of Chutes in Metalliferous Deposits. Edwin E. Chase. Comments on a specimen boulder from the Calumet and Hecla conglomerate, and its bearing on the distribution of copper in the Lake Superior copper lodes. 4500 w. Ec-Geol—March, 1909. No. 3257 D.

**Norway.**

Ore Reduction at the Telemarken Copper Mine, Norway. W. E. Bennett. Illustrated description of a concentrating plant using the vacuum process direct without intermediary treatment. 1600 w. Min Jour—March 13, 1909. No. 3415 A.

**Quebec.**

The Opasatika Lake District, Province of Quebec. Fritz Cirkel. Brief account of copper bearing veins in an inaccessible district. Map. 1200 w. Eng & Min Jour—Feb. 27, 1909. No. 2862.

**Smelters.**

An Up-to-Date 30-Ton Copper Smelting Plant. Charles C. Christensen. Discusses smelting mixtures, the power plant, furnace and blower. Ills. 1500 w. Min Wld—Feb. 27, 1909. No. 2866.

**Sweden.**

See Sulphur, under MINOR MINERALS.

## GOLD AND SILVER.

**Alaska.**

See Placers, under GOLD AND SILVER.

**Arizona.**

Mining and Milling in Tombstone District, Ariz. S. F. Shaw. Describes methods of unwatering, mining and ore treatment. Ills. 1200 w. Min Wld—March 27, 1909. No. 3546.

**Australia.**

The Southern End of the Bendigo Goldfield. Donald Clark. Plans and report of opportunities for further work. 1200 w. Aust Min Stand—Jan. 13, 1909. Serial, 1st part. No. 3046 B.

East Murchison Goldfield, Western Australia. Reviews recent reports by Charles G. Gibson and A. Montgomery, discussing the prospects of Wiluna and other centers. 4000 w. Aust Min Stand —Feb. 10, 1909. No. 3140 B.

See also same title, under COPPER; and Stoping, under MINING.

**Colombia.**

Travel in Colombia. Courtenay De Kalb. Explains conditions in this country of the tropics, and the promising outlook for gold mines. 2000 w. Min & Sci Pr—March 6, 1909. No. 3090.

Mining Industry of Antioquia, Colombia, S. A. Silas H. Wright. An illustrated description of this richly mineralized region, and the conditions existing there. The present number considers mainly the auriferous gravel deposits. 4500 w. Min Wld—March 20, 1909. Serial, 1st part. No. 3434.

**Cyaniding.**

Precipitation from Cyanide Solutions by Zinc Shavings and Dust: A Comparison of Results and Costs. Allen J. Clark. 1000 w. Jour Chem, Met & Min Soc of S Africa—Jan., 1909. No. 3143 E.

Cyaniding Silver Ore in Honduras. George E. Driscoll. Describes the treatment, giving results that show the silver ores are amenable to cyanidation. Ills. 2000 w. Min & Sci Pr—March 13, 1909. No. 3230.

Treatment of the Gold and Silver Precipitate at Dos Estrellas. Walter Neal. Describes method. 800 w. Min & Sci Pr —Feb. 27, 1909. No. 2950.

The Standard Consolidated Cyanide Mill. S. F. Shaw. Describes methods used at Bodie, Cal. Ills. 1500 w. Eng & Min Jour—March 6, 1909. No. 2977.

**Hydraulic Mining.**

See Bucket Elevators, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

**Mexico.**

Progress in Mexican Metallurgy. Kirby Thomas. Reviews the progress of the last 25 years especially, and the promise

of success in treating the low-grade ores. 1200 w. Min Jour—March 20, 1909. No. 3612 A.

Santa Barbara Mine, Chihuahua, Mexico. Describes the mining operations on a large body of silver ore. 2500 w. Mines & Min—March, 1909. No. 2955 C.

**Nevada.**

The Mines and Mills of Tonopah, Nevada. G. E. Wolcott. Illustrates and describes methods used in these gold-silver mines. Cyanide mills now treat the low-grade ore. 1200 w. Eng & Min Jour—March 20, 1909. No. 3263.

See also Open Cut, under MINING; Gold Milling, under ORE DRESSING AND CONCENTRATION.

**New Zealand.**

The Geology of the Mikouni Subdivision, North Westland. Percy Gates Morgan. An illustrated description of the region, the alluvial mining, and the deposits of gold, silver, coal, and information concerning other industries. 6000 w. N Z Mines Rec—Jan. 16, 1909. Serial, 1st part. No. 3042 B.

**Placers.**

Placer Gold Mining in Interior Alaska. Information concerning conditions, methods, and prospecting. 4000 w. Eng & Min Jour—March 20, 1909. No. 3262.

**Rand.**

The Origin of the Gold of the Rand Goldfield. John W. Gregory. Summary of a paper read and discussed before the Inst. of Min. & Met. Examines the theories advanced. Ills. 3500 w. Ec-Geol—March, 1909. No. 3254 D.

Interesting Study of the Transvaal Ore Deposits. Etienne A. Ritter. Briefly explains the geology and petrography, giving the four hypotheses advanced to account for the deposition of the gold. 1200 w. Min Wld—March 13, 1909. No. 3127.

See also Labor, under MINING.

**Refining.**

Apparatus for Electrolytic Refining of Precious Metals. H. Lacroix. Illustrated description of an improved electrolytic refining apparatus and its operation. 1800 w. Elec-Chem & Met Ind—March, 1909. No. 2982 C.

**Utah.**

Properties of the Silver King Coalition Co., Utah. Duncan MacVichie. History and illustrated description, from the last annual report. 3000 w. Min Wld—March 6, 1909. No. 3017.

## IRON AND STEEL.

**Assaying.**

Methods for the Determination of Iron in Ores. Richard K. Meade. Gives three methods of analysis in use many years in the laboratory of the writer. 4000 w. Min Wld—March 27, 1909. No. 3543.

**Bessemer Process.**

The Basic Bessemer Process. Abstract translation from *Stahl und Eisen* of results of an exhaustive chemical investigation by German engineers. 2800 w. Ir Age—March 18, 1909. No. 3213.

**Blast-Furnace Charging.**

Blast-Furnace Chargers. Illustrates and describes various types of chargers in use in Europe. 2800 w. Ir & Coal Trds Rev—March 12, 1909. No. 3429 A.

**Blast-Furnace Gas.**

The Development of Blast-Furnace Gas Purifying. C. Flossel. Brief review of devices tried, with illustrated description of a new design of an axial purifying plant. 1000 w. Ir & Coal Trds Rev—March 19, 1909. No. 3629 A.

**Blast-Furnace Practice.**

Old and Modern Practice in Blowing-in Blast Furnaces (Die Inbetriebsetzung von Hochöfen sonst und jetzt). Fritz W. Lürmann. A comparison of methods and results. 2500 w. Stahl u Eisen—Feb. 10, 1909. No. 3359 D.

Blast-Pressure at the Tuyeres and Inside the Furnace. R. H. Sweetser. A report of tests. 1800 w. Bul Am Inst of Min Engrs—March, 1909. No. 3471 F.

**Blast Furnaces.**

See Electro-Metallurgy, under MINING AND METALLURGY, IRON AND STEEL.

**Canada.**

Iron Ores and Smelting in Canada (Eisenerze und ihre Verhüttung in Kanada). E. Kraynik. A general review of the industry. Ills. 7000 w. Stahl u Eisen—Feb. 24, 1909. No. 3363 D.

**Electro-Metallurgy.**

Melting Metals in the Induction Furnace. An illustrated article presenting the advantages of the induction furnace and giving results of experiments by the American Electric Furnace Co. 2500 w. Ir Trd Rev—March 25, 1909. No. 3507.

Deoxidation and Desulphurization in Electric Steel Furnaces. Dr. R. Amberg. Compares the different electric steel furnaces with respect to the degree and distribution of temperature. 1000 w. Elec-Chem & Met Ind—March, 1909. No. 2986 C.

Blast Furnaces and Electric Furnaces (Hochofen und elektrischer Ofen). A comparison of the two for the production of pig iron. 2800 w. Stahl u Eisen—Feb. 24, 1909. No. 3364 D.

The Production of Pig Iron in the Electric Furnace and in the Blast Furnace (Produzione della Ghisa al Forno elettrico ed all alto Forno). Bemo Catani. A comparison of the two methods. Serial, 1st part. 2800 w. Industria—Feb. 7, 1909. No. 3352 D.

**Exhibitions.**

Iron and Steel at the Franco-British Exhibition. H. Bauerman. Detailed descrip-

tion of exhibits, arranged under their respective districts. 14000 w. Jour Ir & St Inst—No. III, 1908. No. 3481 N.

**India.**

India as an Iron Producer. Information concerning the ancient workings, the materials available, the difficulties experienced, etc. 2500 w. Engr, Lond—March 12, 1909. Serial, 1st part. No. 3425 A.

**New York.**

The Clinton Ores of New York State. D. H. Newland. A summary of the more important economic features as shown in recent investigation. The occurrence of iron ores, their origin, and mining operations. Ills. 5000 w. Bul Am Inst of Min Engrs—March, 1909. No. 3470 F.

**Open Hearth.**

See Steel Works, under IRON AND STEEL; and Gas Producers, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

**Pig Iron.**

Pig-Irons and Their Use. E. Adamson. Abstract of a paper read before the Staffordshire Ir. & St. Inst. Classifies the various pig-irons, and briefly considers the effect of carbon, silicon, sulphur, phosphorus, and manganese, the tests, and grading. 4500 w. Ir & Coal Trds Rev—Feb. 26, 1909. No. 3074 A.

**Pipe Making.**

Heid Spirally Rolled Steel Pipes (Spiralgewalzte Stahlrohre, System Heid). E. v. Radinger. Describes the product, the process of manufacture, and the applications. Ills. 1800 w. Stahl u Eisen—Feb. 10, 1909. No. 3360 D.

**Rolling Mills.**

Power Requirements in Rolling Steel. Gives some results of the investigations of a special German commission. 1700 w. Ir Age—March 11, 1909. No. 3077.

Large Rail and Billet Mills at the Gary Steel Plant. Describes large mills designed for highest efficiency. 2200 w. Eng News—March 4, 1909. No. 2997.

Lead in Rolls (Ueber das Voreilen beim Walzen). J. Puppe. A description of the phenomena and a review of theories, with results of tests. Ills. 5500 w. Stahl u Eisen—Feb. 3, 1909. No. 3357 D.

See also Pipe Making, and Steel Works, under IRON AND STEEL.

**Sand Boils.**

Sand Boils. J. J. Fred Brand. An account of experiments made to determine their causes and prevention. 1200 w. Eng & Min Jour—Feb. 27, 1909. No. 2863.

**Steel Making.**

Manufacture of Steel for Castings. Bradley Stoughton. The open-hearth acid and basic furnaces are compared with the side-blow converter and crucible processes. 3000 w. Foundry—March, 1909. No. 2946.

Modern Methods of Bridge Construction. Explains methods and plant used by first-class British works. 5500 w. Engr, Lond—Feb. 19, 1909. No. 2897 A.

**Steel Works.**

Jonas & Colver's New Steel Works at Sheffield. Illustrated description of a modern plant for rolling the better grades of open-hearth steel. 2500 w. Ir & Coal Trds Rev—Feb. 26, 1909. No. 3075 A.

See also Electric Driving, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

**Tariff.**

See same title, under INDUSTRIAL ECONOMY.

**U. S. Steel Corporation.**

The United States Steel Corporation's 1908 Report. Reviews this report, which shows a great decline in earnings. 6500 w. Ir Age—March 25, 1909. No. 3482.

## LEAD AND ZINC.

**Lead.**

See same title, under MECHANICAL ENGINEERING, MATERIALS OF CONSTRUCTION.

## MINOR MINERALS.

**Alkaline Earths.**

A System of Qualitative Analysis for the Common Elements. William C. Bray. Contribution, No. 39, from the Research Laboratory of Physical Chemistry of the Mass. Inst. of Tech. This fourth article of a series treats of the analysis of the alkaline earth and alkali groups. 15500 w. Tech Qr—Dec., 1908. No. 3440 E.

**Aluminium.**

Aluminium. E. B. Wilson. Its uses, sources, assay processes, etc. 1800 w. Mines & Min—March, 1909. No. 2956 C.

**Antimony.**

See Alloys, under MISCELLANY.

**Asbestos.**

Depth of Asbestos Deposits. Fritz Cirkel. Read before the Can. Min. Inst. A study of the geology and origin. 2500 w. Can Min Jour—March 1, 1909. No. 3016.

On the Asbestos Deposits of the Eastern Townships of Quebec. John A. Dresser. Describes the geology, the deposits, and gives other information. Ills. 2500 w. Ec-Geol—March, 1909. No. 3255 D.

**Diamonds.**

The Copeton Diamonds, New South Wales. A. R. Pike. Notes on the alluvial deposits and the diamond matrix of this field. 2500 w. Aust Min Stand—Jan. 27, 1909. Serial, 1st part. No. 3047 B.

**Manganese.**

Manganese, a Metal of the Future (Un Métal d'Avenir: le Manganèse). A review of its properties, ores, sources, applications, etc. 2000 w. Monit Indus—Feb. 13, 1909. No. 3329 D.

*We supply copies of these articles. See page 319.*

**Nickel.**

The Best Method for the Electrolytic Separation of Nickel (Wie schudet man Nickel am Besten ab auf elektrolytischem Wege?). Results of tests under various conditions. Serial, 1st part. 1500 w. Elektrochem Zeitschr—Feb., 1909. No. 3356 D.

**Ocher.**

The Mining and Treatment of Ocher in Georgia. S. Mays Ball. Describes the deposits, their mining and preparation for market. Ills. 1500 w. Min Wld—March 6, 1909. No. 3021.

**Oil.**

Studies in the Application of the Anticlinal Theory of Oil and Gas Accumulation. Malcolm J. Munn. This paper considers the structural and statigraphic position of certain oil pools in western Penn. with the object of showing that the accumulations are not due to movement by difference in gravity of oil and salt water contained in the oil bed. Ills. 5500 w. Ec-Geol—March, 1909. No. 3256 D.

Oil Measures in the Coalinga District. William Forstner. An account of this district in California. 1200 w. Min & Sci Pr—March 13, 1909. No. 3229.

A Sketch of the Geology of the Baku and European Oil Fields. Leonard V. Dalton. Describes only the regions which have contributed appreciably to the world's supply of petroleum—the Caucasus, Rumania, and Galicia. Maps. 7500 w. Ec-Geol—March, 1909. No. 3253 D.

See Illinois, under COAL AND COKE; and Air Lift, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

**Phosphates.**

Mining and Milling Florida Phosphates. C. A. Stone. Illustrates and describes the method of mining and preparation for market. 1200 w. Eng & Min Jour—March 6, 1909. No. 2978.

**Sulphur.**

Pyrites Mining in Scandanavia (Der skandanavische Kiesbergbau). Herr Spackeler. Describes the deposits and working of copper and iron pyrites, the production of copper and sulphur, etc. Ills. Serial. 1st part. 3600 w. Glückauf—Feb. 20, 1909. No. 3370 D.

**Tin.**

The Origin of Tin Deposits. J. B. Scrivenor. Read before the Perak Chamber of Mines. A study based on the classification of W. H. Emmons. 3000 w. Min Jour—March 6, 1909. Serial. 1st part. No. 3161 A.

The Dolcoath. Lionel C. Ball. The first of a series of illustrated articles on tin mining and milling in Cornwall, England. 3000 w. Queens Gov Min Jour—Feb. 15, 1909. Serial. 1st part. No. 3138 B.

**Uranium.**

Uranium Mining. Information concerning the mining of the ore and how radium is obtained from it. 1200 w. Sci Am Sup—March 6, 1909. No. 3578.

**Vanadium.**

Vanadium-Deposits in Peru. D. Foster Hewitt. Describes two districts where deposits of vanadium have been found and investigation of the nature of the deposits. Ills. 5500 w. Bul Am Inst of Min Engrs—March, 1909. No. 3472 F.

## MINING.

**Drilling.**

Practical Points for Operating the Banka Drill. J. Chisholm. Illustrated notes, describing its use in prospecting in British Guiana. 2500 w. Min Jour—Feb. 20, 1909. No. 2890 A.

Mechanically Operated Rock Drills with Special Reference to Tunnel Boring in the Alpine Tunnels (Ueber maschinell betriebene Gesteinsbohrungen mit besonderer Berücksichtigung des Stollenvortriebes in den Alpentunnels). Otto Schneller. Describes the various types used and gives results. Ills. Serial. 1st part. 5000 w. Zeitschr d Oest Ing u Arch Ver—Feb. 26, 1909. No. 3398 D.

**Drills.**

Ways of Improving Piston and Hammer Drills. Eustace M. Weston. Discusses the comparative merits of hammer and piston drills, suggesting the use of heavier steel, a shorter and quicker stroke, better lubrication, etc. 4000 w. Eng & Min Jour—March 13, 1909. No. 3119.

**Education.**

See same title, under INDUSTRIAL ECONOMY.

**Electric Hoisting.**

Electric Hoists as Adapted for Coal Mines. R. H. Rowland. Discusses the advantages of electric winding and compares the most approved equalizing systems. 3500 w. Eng & Min Jour—Feb 27, 1909. No. 2859.

Electric Hoist at the Elisabeth Collieries, Baulet, Belgium (Machine d'Extraction électrique des Charbonnages Elisabeth, à Baulet, Belgique). Illustrated description. 3700 w. Génie Civil—Feb. 27, 1909. No. 3346 D.

Electric Generating and Hoisting Plants at the Friedrichshall Potash Mines (Elektrische Zentrale und Schachtförderanlage der Kaliwerke Friedrichshall). M. Henke. Illustrated description. 2600 w. Glückauf—Feb. 20, 1909. No. 3371 D.

**Electric Power.**

The Direct-Current Motor in Mining Service. C. S. McGinnis. Considers troubles most likely to occur in practice and remedies which will dispose of the

"inductive kick." Diagrams. 1500 w. Min Wld—March 27, 1909. No. 3544.

**Explosives.**

Accidents from Use of Explosives. Jared W. Stark. Prize paper. Discusses proper methods of storing, transporting, loading and firing explosives. 4000 w. Mines & Min—March, 1909. No. 2958 C.

**Haulage.**

Underground Electrical Haulage. Information concerning the success of electric haulage in the Victoria deep leads. Ills. 1800 w. Aust Min Stand—Feb. 17, 1909. No. 3589 B.

A New Departure in the Hauling of Coal at the Working Face. Illustrates and describes a new method, using swing conveyors, in successful operation at the Rheinpreussen Colliery, in Westphalia. 2500 w. Ir & Coal Trds Rev—March 12, 1909. No. 3432 A.

See also Ore Handling, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

**Hoisting.**

Bennett's Patent Safety Rope Detaching Gear and Cage Retainer. Illustrated description of a safety retaining gear to prevent overwinding. 1200 w. Col Guard —March 19, 1909. No. 3614 A.

**Labor.**

White Labor in Mining. Tom Johnson. Considers the subject from the viewpoint of conditions in South Africa. 2500 w. Jour Chem, Met, & Min Soc of S Africa —Jan., 1909. No. 3144 E.

**Management.**

The Practical Mine Manager and Engineering. Abstract of a lecture by James B. Lewis, in the Melbourne University course. 2500 w. Aust Min Stand—Feb. 10, 1909. No. 3141 B.

**Mine Dams.**

Protection of the Vereinigte Engelburg Colliery against the Rising Water in the Idle Vereinigte Maria Anna and Steinbank Colliery (Die Sicherung der Zeche Vereinigte Engelsburg gegen die hochgehenden Wasser der stillgelegten Zeche Vereinigte Maria Anna und Steinbank) Herr Battig. Illustrated description of the protection works. 2600 w. Glückauf—Feb. 6, 1909. No. 3369 D.

See also Mining, under COAL AND COKE.

**Mine Examination.**

The Professional Examination of Undeveloped Mineral Properties. Charles Catlett. Suggestions in regard to examinations and reports. 3500 w. Bul Am Inst of Min Engrs—March, 1909. No. 3474 F.

**Mine Sampling.**

Sampling Native Copper Deposits. Harley E. Hooper. Brief description of method used by the writer. 600 w. Aust Min Stand—Feb. 3, 1909. No. 3139 B.

Observations on Sampling in the Rand and Rhodesian Mines. H. F. Lofts. Discusses the work of the sampler, and the method of dealing with the occurrence, and systems of valuation. 2800 w. Min Jour—Feb. 20, 1909. No. 2889 A.

See also Prospecting, under MINING.

**Open Cut.**

Glory-Hole Mining at De Lamar, Nevada. W. R. Wardner. Illustrated description of the workings. The material is drawn from an old ore chute, the total cost of extraction being less than 34 cts. a ton. 1200 w. Eng & Min Jour—Feb. 27, 1909. No. 2860.

**Problems.**

On Some Unsolved Problems in Metal-Mining. Prof. Henry Louis. ("James Forrest" lecture.) Introductory remarks followed by a consideration of prospecting, opening up mineral deposits, exploitation, transportation, dressing of minerals, and workers safety. 15000 w. Inst of Civ Engrs—April 27, 1908. No. 3211 N.

**Prospecting.**

Churn-Drill Sampling. W. E. Thorne. Brief illustrated discussion of the best practice. 1000 w. Min & Sci Pr—March 6, 1909. No. 3092.

See also Drilling, under MINING.

**Recording Apparatus.**

Electric Recording Apparatus for Mine Watchmen. Carl L. C. Fichtel. Ill. Illustrates and describes the mechanism and its operation. 1000 w. Eng & Min Jour —Feb. 27, 1909. No. 2861.

**Shafts.**

Reclaiming the Inclined Hoistway at Mine 21. Guy C. Stoltz. Describes methods at Mineville, N. Y., and the accident to the hoistway, and methods of reclaiming it. Ills. 1000 w. Eng & Min Jour—March 20, 1909. No. 3264.

**Shaft Sinking.**

Sinking in Wet Ground by Injecting Concrete. Jules Lombois. Abstract trans. from *Bul. de lo Soc. d. l'Ind Min.* Describes the method. Ills. 2500 w. Eng & Min Jour—March 27, 1909. No. 3534.

Problems of Shaft Sinking in a Michigan Salt Mine. Norman B. Beasley. An interesting account of methods used to overcome great difficulties. A persistent flow of sulphur water, inflow of silt, bad air causing blindness, etc. 1500 w. Min Wld—March 20, 1909. No. 3435.

**Stoping**

"Shrinkage" Stoping in Western Australia. F. Percy Rolfe. Describes this method of stoping used at the Lake View Consol Gold Mine, discussing its advantages and disadvantages. Ills. 4000 w. Inst of Min & Met, Bul. 53—Feb. 11, 1909. No. 3160 N.

*We supply copies of these articles. See page 319.*

**Surveying.**

Levelling Results and Their Treatment (Nivellementaufgaben und ihre Behandlung). Viktor Kadainka. A discussion of levelling with special reference to mine surveying, the reduction and plotting of notes, etc. Ills. Serial. 1st part. 1800 w Oest Zeitschr f Berg u Hüttenwesen—Feb. 13, 1909. No. 3367 D.

**Timbering.**

Concrete in Mine Support. W. R. Crane. Describes uses made of concrete in mines, its substitution for timber, etc., giving a bibliography. Ills. 3500 w. Min & Sci Pr—Feb. 27, 1909. No. 2949.

Strength of Timber vs. Reinforced Concrete. Ernest McCullough. A comparison, with discussion of the proper mixing of the concrete. 2500 w. Min Wld—March 6, 1909. No. 3018.

## ORE DRESSING AND CONCENTRATION.

**Briquetting.**

The Briquetting of Iron Ores by the Method of the "Deutsches Brikettierungs-Gesellschaft" (Eisenerzbrikettierung nach dem Verfahren der "Deutschen Brikettierungs-Gesellschaft," Altenkirchen). R. Goebel. Describes the method and gives costs of plant and operation. 2800 w. Stahl u Eisen—Feb. 17, 1909. No. 3361 D.

**Elmore Process.**

Elmore Vacuum Process at Broken Hill, New South Wales. Stanley Elmore. Illustrated description of the installation of the Zinc Corporation, Ltd. 2000 w. Min Jour—Feb. 20, 1909. No. 2888 A.

**Gold Milling.**

Milling Conditions in the Goldfield District, Nev. A. H. Martin. Describes the complex ores, and the problems of their treatment. Illustrated description of the 100-stamp mill and its operation. 3000 w. Min Wld—March 13, 1909. No. 3123.

Milling at Grass Valley and Nevada City. G. E. Wolcott. Employs amalgamation, concentration, and cyanide treatment. Concentrates are not treated at the mill. Ills. 2000 w. Eng & Min Jour—Feb. 27, 1909. No. 2858.

**Jigs.**

Richards Pulsator Jig and Classifier. Frank E. Shepard. Describes two devices for the concentration and classification of ores. 3500 w. Eng & Min Jour—March 13, 1909. No. 3118.

**Screening.**

See same title, under COAL AND COKE.

**Sizing.**

Close Sizing of Dry Finely Crushed Ores. E. Goodwin Steele. Discusses the construction and advantages of the vibromotor sizer for dry ores, and gives results of tests. Ills. 2500 w. Eng & Min Jour—March 6, 1909. No. 2979.

## MISCELLANY.

**Metal Production.**

The World's Annual Metal Crop. Theo. F. Van Wagenen. A review of the metals now known, and their uses, and the wonderful progress recently made in the production of the true metals. 5500 w. Pop Sci M—March, 1909. No. 2920 C.

**Mexico.**

A Classification of the Ore Deposits of Mexico. Ezequiel Ordóñez. Briefly describes the mountain systems and the principal ore deposits. 1600 w. Min Jour—March 20, 1909. No. 3611 A.

**Ore Deposits.**

Discussion on "A Theory of Volcanic Action and Ore Deposits, Their Nature and Cause" by Hiram W. Hixon, and on "The Silver Islet Vein, Lake Superior" by Walter McDermott. 17500 w. Inst of Min & Met, Bul 53—Feb. 11, 1909. No. 3159 N.

The Association of Ores and Country Rock. Gordon Surr. Notes on the occurrences of various minerals. 3500 w. Min Wld—March 13, 1909. No. 3124.

Distribution of Metals and Minerals in Ore Shoots. Gordon Surr. Considers causes of the uneven distribution. 2500 w. Min Wld—Feb. 27, 1909. No. 2867.

Modern Ancient Volcanoes and Ore Deposits. Arthur Lakes. A study of the relation between igneous intrusive rocks and ore occurrence. Ills. 2500 w. Min Wld—March 27, 1909. No. 3545.

Ores in Volcanic Craters and Fumarole Orifices. Arthur Lakes. Describes examples showing how varied are the methods of ore occurrences. Ills. 2000 w. Min Wld—March 6, 1909. No. 3019.

See Lake Superior, under COPPER; Rand, under GOLD AND SILVER; and Asbestos, under MINOR MINERALS.

**Ores.**

What Is an Ore? James F. Kemp. Read before the Can. Min. Inst. An examination of the term in its technical sense, and in the scientific sense. 4500 w. Min & Sci Pr—March 20, 1909. No. 3506.

**Respirators.**

The Improvement of Respirators (Ein Beitrag zur Verbesserung von Staubschutzrespiratoren). Arpád Kriz. A description of various types. Ills. 2200 w. Oest Zeitschr f Berg u Hüttenwesen—Jan. 23, 1909. No. 2671 D.

**Utah.**

Mineral Resources of Utah. Robert H. Bradford. Abstract of paper read before the Am. Min. Cong. Reviews the production of the more important mines. Lead, silver, gold, copper and valuable non-metallic minerals, salt, coal, asphalt and other deposits are found. 2000 w. Min & Sci Pr—Jan. 30, 1909. No. 2291.

*We supply copies of these articles. See page 319.*

# RAILWAY ENGINEERING

## CONDUCTING TRANSPORTATION.

**Dispatching.**

The Telephone for Train Dispatching. W. E. Harkness. Presents the advantages of the telephone over the telegraph for dispatching purposes, giving information of installations and their working. Discussion. 1300 w. Pro St Louis Ry Club—Feb. 12, 1909. No. 2928.

**Signalling.**

Railway Signalling. John Murphy. An investigation of railway signal systems and their operation with special reference to work needed in Canada. 4000 w. Can Engr—March 12, 1909. No. 3114.

The First Block Signal System in America. J. A. Anderson. An account of the system devised and put in operation by Ashbel Welch. Ills. 2800 w. R R Age Gaz—March 5, 1909. No. 3033.

A Little Further Talk on Torque and Its Relations to an Upper Quadrant Signal. W. H. Lane. Discusses the conditions under which a signal must operate and the need of a standard design. 2000 w. Sig Engr—March, 1909. No. 3237.

Signal Lightning Arresters. E. E. F. Creighton. General consideration, with discussion of materials, tests, etc. Ills. 2500 w. Sig Engr—March, 1909. No. 3236.

See also Reinforced Concrete, under CIVIL ENGINEERING, CONSTRUCTION.

**Train Movements.**

Mr. Metzel's Diagram and That of the Belgian State Railway for Investigating the Utilization of Tracks at Passenger Stations. L. Weissenbruch and J. Verdeyen. 1600 w. Bul Int Ry Cong—Feb., 1909. No. 3276 G.

**Train Weights.**

The Maximum Weights of Slow Freight Trains. C. S. Bissell. A study of data to determine the maximum train weight for slow freight. 2500 w. Pro Am Soc of Civ Engrs—Feb., 1909. No. 3461 E.

## MOTIVE POWER AND EQUIPMENT.

**Air Brakes.**

The Application of Automatic Continuous Brakes to Goods Trains (Sull' Applicazione di Freni continui automatici ai Treni Merci). Ferruccio Celeri. An elaborate discussion of the whole problem Ills. 20000 w. Ing Ferro—Feb. 26, 1909. No. 3355 F.

**Baggage Trucks.**

The Economy of Power Baggage Trucks for Station Platforms (Die Wirtschaftlichkeit der Bahnsteig-Gepäckaufzüge bei verschiedener Betriebsweise). Fritz Landsberg. Examines the cost of hydraulic and electrically operated systems. 2300 w. Glasers Ann—Feb. 1, 1909. No. 3394 D.

**Car Ferries.**

See Ferryboats, under MARINE AND NAVAL ENGINEERING.

**Car Lighting.**

Appliance for Putting in Place Inverted Mantles into the Lamps of Railway Passenger Carriages. Mr. Epstein. Illustrated description, 800 w. Bul Int Ry Cong—Feb., 1909. No. 3278 G.

**Car Repairing.**

Maintenance and Repair of Freight Cars. Full illustrated detailed description of methods used by the Pennsylvania Railroad, with special reference to steel equipment. 10000 w. Am Engr & R R Jour—March, 1909. No. 2963 C.

**Derrick Cars.**

See Erection, under CIVIL ENGINEERING, BRIDGES.

**Electrification.**

The Electrification of Railways.—A General Comparison of Systems. F. W. Carter. Read before the Rugby Engng Soc. Compares in a general way the merits and demerits of the various systems of operation, showing that no one system satisfies all needs, and indicates the class of work to which each is suited. 3000 w. Elec Engr, Lond—Feb. 26, 1909. No. 3051 A.

**Locomotive Boilers.**

Combustion and Heat Absorption in Locomotive Boilers. Lawford H. Fry. A study based on the tests carried out by the Pennsylvania Railroad Company. 4500 w. Engng—Feb. 19, 1909. Serial. 1st part. No. 2892 A.

**Locomotive Fire Boxes.**

Jacobs-Shupert Locomotive Fire Box. H. W. Jacobs. Illustrated description of a new design which is being applied to the "Santa Fe type" engine, and to the new passenger Mallet type engines. 2500 w. Am Engr & R R Jour—March, 1909. No. 2964 C.

**Locomotive Fuels.**

Burning Heavy Residuum Oils in the Locomotives of the Roumanian State Railways (Le Chauffage au Huiles lourdes de Pétrole des Locomotives des Chemins de Fer De l'Etat roumain). Illustrated description of the fire box, etc. 2000 w. Génie Civil—Feb. 6, 1909. No. 3338 D.

**Locomotives.**

Bodmer's Balanced Locomotives. Herbert T. Walker. Reproductions of original

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drawings, with description of designs of Bodmer, dating back to 1834. 3500 w. Engr, Lond—March 5, 1909. No. 3176 A.

Vauclain Compound Atlantic Type Locomotive. Illustrated description of engines for heavy passenger service on the C. M. & St. P. Ry. 800 w. Am Engr & R R Jour—March, 1909. No. 2965 C.

Mallet Articulated Compound Locomotives for France. Plate and illustrated description, with dimensions. 1000 w. Engr, Lond—March 19, 1909. No. 3672 A.

Freight Tank Locomotives for the Prussian State Railways. An editorial study of these engines, which are equipped with the Schmidt smoketube superheater, as examples of German practice, comparing with the practice in the United States. 2000 w. R R Age Gaz—March 5, 1909 No. 3030.

Ten-Coupled Mineral Locomotive; Swedish State Railways. Illustration and particulars of a recent type of engine for handling the ore traffic. 200 w. Engng—March 19, 1909. No. 3619 A.

The New Types of Locomotives for the Italian State Railways (I nuovi Tipi di Locomotive delle Ferrovie italiane di Stato). Illustrated description with results of tests. Serial. 1st part. 3500 w. Monit Tech—Feb. 28, 1909. No. 3351 D.

**Locomotive Springs.**

Locomotive Springs. J. A. Kinkead. Abstract of a paper before the Can. Ry. Club. Gives table issued by the Am. Loc. Co., and considers modulus, material, flexibility, testing and failures. 2500 w. R R Age Gaz—March 12, 1909. No. 3098.

**Locomotive Superheating.**

The Advantages of the Use of Moderately Superheated Steam in Locomotive Practice. Lawford H. Fry. Shows that so far as coal consumption is concerned, a low degree of superheat offers the same opportunity for economy as does a very high degree. 2500 w. R R Age Gaz—March 5, 1909. No. 3034.

**Locomotive Tenders.**

Tender for Six-Coupled Express Locomotive; Bengal-Nagpur Railway. Illustrated description with particulars of engine and tender. Plate. 500 w. Engng—March 5, 1909. No. 3167 A.

**Locomotive Valve Gears.**

Valve Motion Design. Sidney C. Carpenter. Considers link motion design from the standpoint of the strain on the various parts. 1500 w. Ry & Loc Engng—March, 1909. No. 2940 C.

The Walschaert Valve Gear. C. O. Rogers. An illustrated explanation of the principles and construction. 3000 w. Sci Am Sup—March 27, 1909. No. 3584.

**Motor Cars.**

The Accumulator Motor Cars of the Prussian State Railways (Die Akkumulator-Doppelwagen der Preussischen Staatsbahn-Verwaltung). Herrn Hönsch and W. Mattersdorff. Illustrated detailed description. 5000 w. Zeitschr d Ver Deutscher Ing—Feb. 6, 1909. No. 3560 D.

**Shops.**

See Car Repairing, under MOTIVE POWER AND EQUIPMENT.

**Water Supply.**

See Boiler Waters, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

## NEW PROJECTS.

**C. C. & O.**

The Carolina, Clinchfield & Ohio Railway. George L. Fowler. Gives the geographical and geological location, describes construction work, stations, equipment, etc. Fully illustrated. 11000 w. R R Age Gaz—March 19, 1909. No. 3289.

**Coal & Coke Ry.**

Construction of the Coal & Coke Ry. Map and illustrated description of line from Elkins to Charleston, W. Va., giving a new route from the Kanawha River to Chesapeake Bay. 1200 w. Ry & Engng Rev—March 27, 1909. No. 3547.

**Transandine.**

The History of the Transandine Railway. An illustrated description and historical review of this project, which will give railway connection between Buenos Ayres and Valparaiso. 3000 w. Bul Am Reps—March, 1909. No. 3191 N.

**Virginian Ry.**

Construction of the Virginian Ry. Illustrated detailed description of the construction work on this line, laid out, principally, to handle the heavy coal traffic between West Virginia and the seaboard at Norfolk. 5000 w. Ry & Engng Rev—March 13, 1909. No. 3136.

**Western Pacific.**

The Western Pacific. P. S. Hildreth. The second of a series of articles dealing with this road now approaching completion. An illustrated account of the location, grading, alinement, terminal facilities, and roadbed. 4000 w. R R Age Gaz—March 19, 1909. No. 3290.

## PERMANENT WAY AND BUILDINGS.

**Ballast.**

Broken Stone and Gravel Plants. From the report on Ballasting, presented at the convention of the Am. Ry. Engng & Main. of Way Assn. Describes a number of plants which supply broken stone or gravel for track purposes. 2500 w. Eng Rec—March 20, 1909. No. 3268.

*We supply copies of these articles. See page 319.*

**Construction.**

See C. C. & O., Coal & Coke Ry., Virginia Ry., and Western Pacific, under NEW PROJECTS; Conveyors, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

**Curves.**

Parabolic Spirals (Raccordi parabolici). E. Benintende. A mathematical discussion of the calculation of transmission ends, with tables. Ills. 2700 w. Monit Tech—Feb. 20, 1909. No. 3350 D.

**Earthwork.**

A Rapid Method of Computing Earthwork (Calcul rapide des Terrassements d'après le Profil en long). M. Bitsanis. A mathematical demonstration of a method of obtaining approximate quantities of cuts and fills. Ills. 2000 w. Ann d Ponts et Chaussées—1908-VI. No. 3316 E + F.

**Elevated Railways.**

Estimated Unit and Total Costs of Railway Track Elevation at Wilkes-Barre, Pa. 1500 w. Engng-Con—March 10, 1909. No. 3095.

**Rail Joints.**

Rail Joints. Information as to the efficiency of different joints summarized from replies to questions sent to important roads. Ills. 2200 w. R R Age Gaz—March 19, 1909. No. 3294.

**Rails.**

The New 85-lb. Rail Section of the Canadian Pacific Ry. Describes the design of this new rail section. Also editorial review of recent development. 3500 w. Eng News—March 11, 1909. No. 3103.

Rolled Manganese Steel Rails. Jas. B. Strong. Information concerning the properties of these rails. Ills. 1500 w. Ry & Engng Rev—March 13, 1909. No. 3135.

The Use of Titanium in Steel for Rails, Car Wheels, Etc. Charles V. Slocum. Explains the important advantages gained by the use of this element. 2200 w. Elec-Chem & Met-Ind—March, 1909. No. 2990 C.

Ferrotitanium Steel Rails. Reports experience of the N. Y. Central lines, and the excellent results secured under the 1908 specifications. 1600 w. Ir Age—March 25, 1909. No. 3485.

**Reconstruction.**

Indianapolis-Terre Haute Double Track of the Big Four. Illustrates and describes work involving a change from single to double track, reducing grades, curves, etc. 2000 w. R R Age Gaz—March 26, 1909. No. 3517.

Restoration of Traffic on the Right Bank of the Rhone Following the Washouts Caused by the Floods of October, 1907 (Rétablissement de la Circulation sur la Rive droite du Rhone à la suite des Coupures causées par les Inondations d'Octobre 1907). M. Ruffieux. Description of the repair work. Ills. 3000 w. Rev Gen de Chemins de Fer—Feb., 1909. No. 3323 G.

**Roundhouses.**

Some Engine House Auxiliaries. William Elmer. Describes auxiliaries that have been found of service in expediting the movement of locomotives at terminals. Ills. Discussion. 8500 w. Pro Ry Club of Pittsburg—Jan. 22, 1909. No. 3192 C.

**Shops.**

A Large Locomotive-Erecting Shop. Illustrated description of erecting shop No. 2, for the N. Y. C. & H. R. R. R. Co. at Albany, N. Y. 2200 w. Eng Rec—March 20, 1909. No. 3271.

**Stations.**

Chattanooga Passenger Terminal Station. Illustrated detailed description of a station serving five railways. 1500 w. R R Age Gaz—March 19, 1909. No. 3292.

**Terminals.**

Louisville and Nashville Terminals at Pensacola. Illustrated description of wharves, track facilities, and improvements for the export and import cargoes. 1000 w. R R Age Gaz—March 12, 1909. No. 3099.

See also Roundhouses, and Stations, under PERMANENT WAY AND BUILDINGS.

**Ties.**

See Timber Preservation, under Civil Engineering, MATERIALS OF CONSTRUCTION.

**Track Construction.**

Track Laying on the Guymard Cutoff of the Erie R. R. Brief illustrated description of the Hurley track-laying machine and its operation. 600 w. Engng-Con—March 10, 1909. No. 3094.

See also Ballast, under PERMANENT WAY AND BUILDINGS; and Earthwork, under CIVIL ENGINEERING, CONSTRUCTION.

**Track Maintenance.**

Annual Maintenance of Way Convention. A report of the Chicago meeting, March 16, 17, 18, 1909, with committee reports, discussions, addresses, etc. Ills. 90000 w. R R Age Gaz—March 19, 1909. No. 3293.

**Train Sheds.**

Bush Train Shed at Scranton. Illustrated description, with a statement of the advantages of these sheds. 1000 w. R R Age Gaz—March 19, 1909. No. 3291.

## TRAFFIC.

**Demurrage.**

Reciprocal Demurrage. F. O. Melcher. A memorandum submitted to the R. R

*We supply copies of these articles. See page 319.*

Committee of the Iowa Senate opposing the adoption of a reciprocal demurrage bill. 2000 w. R R Age Gaz—March 26, 1909. No. 3515.

Handling Merchandise Shipments from Chicago to the South and Southeast. Samuel O. Dunn. Explains the conditions and methods introduced to secure bettêr service. Map. 2500 w. R R Age Gaz—March 5, 1909. No. 3035.

**Freight Offices.**

Local Freight Office Efficiency, from the Viewpoint of the General Freight Office. Charles R. French. Discusses matters that affect the efficiency and service. 3500 w. R R Age Gaz—March 5, 1909. Serial. 1st part. No. 3036.

**Freight Rates.**

Co-operative Freight Traffic. Alfred H. Post. Address before the Cincinnati Branch Nat. Metal Trds. Assn. 2000 w. Ir Age—March 18, 1909. No. 3214.

### MISCELLANY.

**France.**

The Redemption of the Lines of the Western Railway of France and Their Organization for State Operation (Le Rachat du Réseau des Chemins de Fer de l'Ouest et l'Organisation de son Exploitation par l'Etat). P. Maurice. Serial. 1st part. 4500 w. Génie Civil—Feb. 13, 1909 No. 3341 D.

**Management.**

Methods of the Santa Fe. Efficiency in the Manufacture of Transportation. Charles Buxton Going. This second article of a series considers the stores-keeping, shop-order and works-order systems. Ills. 4000 w. Engineering Magazine—April, 1909. No. 3523 B.

**N. Y., N. H. & H.**

The New England Railroads. Thomas Warner Mitchell. Review of the accountant's analysis of the reports of the New York, New Haven and Hartford, and the Boston and Maine railroad systems. 5500 w. Jour of Acc—Feb., 1909. No. 2916 C.

**United States.**

The Railroad Situation of To-day. Frank Trumbull. Discusses the problem of how to settle satisfactorily the relations between private capital and the users of American railroads. 4500 w. Jour W Soc of Engrs—Feb., 1909. No. 3297 D.

Southern Railways and Their Needs. John F. Wallace. From an address before the So. Com. Cong. Outlines the additional facilities needed and their cost. 2000 w. R R Age Gaz—March 5, 1909. No. 3031.

**Valuation.**

The Valuation of Railways. Considers some of the benefits that may be expected to result from valuation, and some of the difficulties. 4500 w. R R Age Gaz—Jan. 22, 1909. Serial, 1st part. No. 2003.

Valuation of Railways in Minnesota. Gives the results of an exhaustive physical valuation, explaining methods used. Also editorial. 6000 w. R R Age Gaz—Feb. 5, 1909. No. 2301.

Appraisal of the Physical Properties of Railroads of Minnesota. Extracts from report of Dwight C. Morgan. Explains the general plan for estimating values, means of securing data, etc. 9500 w. Ry & Engng Rev—March 13, 1909. No. 3137.

An Analysis of the Appraisal of the Railways of Minnesota with Comments on the Same. A review of the report of Dwight C. Morgan to the Railroad and Warehouse Commission of Minnesota. 4000 w. Engng-Con—March 3, 1909. No. 3027.

The Work of the Joint Engineering Staff of the Wisconsin Tax and Railroad Commission. William D. Pence. An account of the valuation work. Discussion. 15000 w. Jour W Soc of Engrs—Feb., 1909. No. 3299 D.

Some Neglected Factors of Fair Valuation. Editorial on the desirability of considering other factors than the cost of reproduction. 1800 w. R R Age Gaz—March 5, 1909. No. 3029.

**Welfare Work.**

Saloons versus Railway Clubs on the Harriman Lines. F. G. Athearn. Illustrated account of the clubs in operation on the Southern Pacific. 2500 w. R R Age Gaz—Jan. 29, 1909. No. 2146.

## STREET AND ELECTRIC RAILWAYS

**Brooklyn Bridge.**

Traffic on the Brooklyn Bridge, New York City. F. van Z. Lane. Considers features of the traffic as an example of high-class operation when traffic density, capacity, safety, comfort, speed and reliability are considered. Deals with the evening rush hour, from 5 to 6 P. M. Plate. 3000 w. R R Age Gaz—March 2, 1909. No. 3096.

**Cars.**

Pay-Within Cars in Philadelphia. Gives an account of conditions to be met, and an illustrated description of the cars finally adopted and their operation. 5000 w. Elec Ry Jour—March 20, 1909. No. 3232.

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New Steel Car of United Railways Company of St. Louis. Illustrated description of a steel passenger car of the pay-as-you-enter type. 1500 w. Elec Ry Jour—March 13, 1909. No. 3088.

New Cars for the Düsseldorf Tramways. Herr Stahl. Illustrated description of semi-convertible cars. 1900 w. Bul Int Ry Cong—Feb., 1909. No. 3279 G.

**Electric Traction.**

Early Experiments in Electric Traction. W. W. Lackie. Presented to the Glasgow Sec. of the Inst. of Elec. Engrs. Information regarding Robert Davidson's experiments in 1837. Ills. 2000 w. Elec Engr, Lond—Feb. 19, 1909. No. 2876 A.

**Interurban.**

New Interurban Line of the Joplin & Pittsburg Railway Company. Illustrated description of a well-built line in Kansas and Missouri. 3000 w. Elec Ry Jour—March 13, 1909. No. 3087.

Extensions of the Joliet & Southern Traction Company. An illustrated account of new construction and other improvements. 3000 w. Elec Ry Jour—March 6, 1909. No. 2959.

The Oregon Electric Railway System. Illustrated detailed description of the portion of the line in operation, connecting Portland, Salem, Hillsboro and Forest Grove. 2500 w. Elec Ry Jour—March 20, 1909. No. 3231.

**Locomotives.**

Electric Locomotives for the G. N. Illustrated description of recently completed electric locomotives for operating trains through the Cascade tunnel. 900 w. Ry & Loc Engng—March, 1909. No. 2938 C.

The New Three-Phase Ganz Locomotives of the Valtellina Railway. H. Marchand-Thiriar. Illustrated detailed description. 2800 w. Bul Int Ry Cong—Feb., 1909. No. 3277 G.

**Pará.**

The Tramways of Pará. An illustrated account of the reconstruction and electrification of the tramways. 3300 w. Tram & Ry Wld—March 4, 1909. No. 3228 B.

The Pará Tramway and Lighting System. An illustrated description of the complete reconstruction of the tramway system, and the installation of electric lighting. 2500 w. Elec Ry Jour—March 6, 1909. No. 2960.

**Power Stations.**

See Central Stations, and Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

**Records.**

Record System of the Third Avenue Railroad Company, New York. Explains system and gives forms that have proved valuable in recording the performance of equipments in detail. 900 w. Elec Ry Jour—March 27, 1909. No. 3509.

**Single Phase.**

Single-Phase Electric Traction on the Swedish State Railways. Abstract of a report prepared by R. Dahlander, dealing with the power house, line and locomotive equipment, etc. 3300 w. Elect'n, Lond—March 5, 1909. No. 3151 A.

**Stray Currents.**

Electric Traction Vagabond Currents. J. G. Cunliffe and R. G. Cunliffe. Read before the Manchester Sec. of the Inst. of Elec. Engrs. An investigation of the principal vagabond current phenomena. 2200 w. Elec Engr, Lond—March 12, 1909. Serial. 1st part. No. 3403 A.

**Subways.**

Progress on the Bridge Loop Subway. Illustrates and describes work on the loop which will connect Brooklyn Bridge terminal with the Manhattan and Williamsburg bridge terminals. 3500 w. Eng Rec—March 27, 1909. No. 3537.

The Bowling Green Improvement of the New York Rapid Transit Railroad. Illustrates and describes changes between Bowling Green station and South Ferry, made necessary by the maximum Brooklyn traffic. 3000 w. Eng Rec—March 13, 1909. No. 3106.

Underground Railway Construction in Paris. A. J. Thompson. Illustrates and describes the recent construction, including difficult tunneling in city streets, reinforced concrete work, etc. 2000 w. Cassier's Mag—March, 1909. No. 2921 B.

See also Caissons, under CIVIL ENGINEERING, CONSTRUCTION.

**Switzerland.**

The Loetschberg Tunnel Electric Railroad. C. L. Durand. Illustrated description of the Bernese Oberland line in Switzerland, and its passage through this important tunnel. 2000 w. Elec Rev, N Y—March 6, 1909. No. 3007.

Standards and Principles for the Electric Operation of the Swiss Railways (Normes et Principes d'un Service de Traction pour l'Exploitation électrique des Chemins de Fer suisses). Dr. Wyssling. Deals with the problems of traffic and train service. Serial. 1st part. 5000 w. Bul Tech d l Suisse Romande—Feb. 10, 1909. No. 3334 D.

**Track Construction.**

See Pavements, under CIVIL ENGINEERING, MUNICIPAL.

**Trunk Lines.**

The Electric Operation of Steam Railways. J. B. Whitehead. Examines the advantages and disadvantages of the electric operation of trunk lines. 5500 w. Pop Sci M—March, 1909. No. 2919 C.

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## EXPLANATORY NOTE—THE ENGINEERING INDEX.

**We hold ourselves ready** to supply—usually by return of post—**the full text of every** article indexed in the preceding pages, *in the original language*, together with **all accompanying** illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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## THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Der Motorwagen. *s-m.* Berlin.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Manich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.